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DESIGN AND ANALYSIS OF AUTOMOBILE WHEEL RIM

Mr. SUNIL PRASHANTH KUMAR[1], MUHAMMAD MANSOOR P[2], VISHAK VIGNESH[3], ABHIJEET KUMAR[4], MORDI SANGMA[5]

[1]Professor, Dept of Automobile Engineering, New Horizon College of Engineering, Bangalore, Karnataka, India
[2,3,4,5]Students, Dept of Automobile Engineering, New Horizon College of Engineering, Bangalore, Karnataka, India

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ABSTRACT – *The wheel rims used in most vehicles are both alloy wheels and steel wheels. Here in this project the material used is aluminium alloy and for the steel rim is structural steel. For the designing of the wheel rims AUTOCAD 2022 version with required dimensions, and the analysis is done using the software ANSYS 2021 R1 version. Wheel rims are categorized into two they are alloy wheel and steel wheel, as for the alloy wheel two different designs have been made they 6 – spoke alloy and multi – spoke alloy. Here analysis is done to know the structural tendency of the designed wheels with defined materials and their properties. Final results are defined with their total deformation, stress obtained and the strain obtained. From all the three based on the total deformation which of them is better than the other is defined and why it is better has also been verified.*

Key words – wheel rims, stress and strain obtained, deformation occurring.

1 INTRODUCTION:

In most of the modern vehicles like the commuter vehicles they prefer both steel wheel and alloy wheel based on their vehicle trims. Most companies prefer steel wheel in order to reduce the cost for their base trims of the particular vehicle. Most alloy wheels are manufactured using aluminium mix with the alloy and even the steel wheels are produced with some mix on the steels. Designs are done based on the structure based with specified dimensions and the analysis also done by the particular structural design in order to identify the structural tendency using structural analysis. Even nowadays most of the alloy wheels are being produced using the titanium, some of the manufacturers are following the above material for preparing the alloy wheel.

1.1 ALLOY WHEEL V/S STEEL WHEEL:

ALLOY WHEEL:

These are the types of wheels which are commonly used by every automobile manufacturer all over the world. Every manufacturer introduces different design and structure for making it different from other vehicles to form a unique design and also, they even check for the capabilities and how the design would be and will it withstand different loads that are appearing on a vehicle and structural rigidity, etc. If the number of spokes increase the structural quality and load tendency of the particular vehicle. Alloy wheels have more strength over the clean and neat metals. Alloy wheels are the mixture of metal and other different elements.

STEEL WHEELS:

These are the wheels which are commonly used in older vehicles and in modern days on few lower prized commuter vehicles. Most luxury vehicles prefer alloy wheels due to their higher prizing for each model and a bit expensive for the normal peoples. So, in order to withstand the normal people's affordability most manufacturers prefer steel wheel for some models. Steels wheels have

more durability which can with stand minor scratches and dents, repairability is easier and cheaper than the alloy wheel. It is a simple design which are followed by mostly every manufacturer. But design wise alloy wheels are more attractive than the steel wheels.

1.2 PRODUCTION OF WHEEL RIMS:

ALLOY WHEELS,

Alloy wheels are mainly produced using aluminium and magnesium by most manufactures. Recently titanium is also being considered for the production of alloy wheel. Designing is done based on the spokes rather than the steel wheels. Spokes for the alloy designing can be varies in different shapes as per the needs of the manufactures. For every material used for the production of alloy wheel has specific properties for the mathematical analysis of the particular alloy wheel, whether it would withstand all the consequences facing while on the different terrains of roads. For the on-road abilities most manufactures use the alloy wheel. The other type of alloy wheels preferred by the automobile manufactures are depends on the light alloy wheels also based on the light metal.

STEEL WHEELS,

These are the wheels where mostly all the automobile manufactures prefer for their cheapest vehicles. For the production of the steel wheels steels are the main material and the structures are the same for each and every vehicle. Steel wheels have same basic design like the older days, where the wheel is designed like covered with a cap with a number of holes around the outer hub and even to make it look like an alloy wheel the outer part of the steel wheel is covered by a cap hub in various design factors based on the vehicle looks.

1.3 ADVANTAGES AND DIS-ADVANTAGES:

ALLOY WHEEL:

ADVANTAGES –

- Most alloy wheels are made using aluminium and magnesium as their materials
- They are more attractive and can be designed in various styles as per requires
- It has fraction of their weight as the steel wheels which makes it more rigid in nature
- It requires less energy to rotate the wheel which helps in better fuel efficiency of the particular vehicle
- Aluminium alloy has 97% of aluminium and the other remaining with amount of alloy.

DIS-ADVANTAGE –

- It has lesser durability than the steel wheels due to their tougher nature
- It has higher repairing expense than the steel wheels due to the material properties chances of breaking of the alloy is higher compared to the steel wheels

STEEL WHEEL:

ADVANTAGES –

- It is cheaper than the alloy wheels which is approximately 70 – 80% that of the alloy wheels
- Steels are stronger than the alloy wheels that's why most of the off-roading vehicles and the load carrying trucks still uses steel wheel due to the lesser impact nature that reduces dent and breaking of the wheel
- It is more repairable than the alloy wheel, which makes it repairing easier and helpful

DIS-ADVANTAGES:

- It has more chances to occur corrosion or rusting nature on the steel wheels
- Since it is having more weight, the suspension makes a beating after sometime driving the vehicle
- It is lesser attractive than the alloy wheel due to the same design opted by all the vehicle manufactures

2 TYPES OF WHEELS DESIGNED:

Designing the alloy wheels are based on the manufactures but the steel wheels are same for every manufacture, so the different designed models are

2.1 6- SPOKE ALLOY WHEEL –

Here the material and the properties are used based on the aluminium alloy. Totally, six spokes are there in this alloy with dimensions and it is done structural analysis

2.2 MULTI-SPOKE ALLOY WHEEL –

The material used is same as that of 6 spoke alloy which is aluminium alloy and their properties for the purpose of analyzing it and to identify structural analysis of the wheel. Here more spokes have been designed in order to find out which one of the alloy wheels has more strength in the structure.

2.3 STEEL WHEEL –

It is designed in order to identify is steel or the alloy is better in the structural analysis. Steel is the main material used to produce the steel wheel, here the material used for the analysis of the structure is used the structural steel and their properties.

3 WHEEL DIMENSIONS :(in mm):

Dimensions are equal for all the three type of wheels.

for 6 spoke alloy wheel,

Rim diameter = 410mm
Rim width = 465mm
Center bore = 40mm
Bolt circles = 20mm
Spoke length = 200mm

For steel wheel,

Rim diameter = 420mm
Rim width = 245mm
Center bore = 35mm
Bolt circles = 20mm
Circles around the outer area = 25mm

For multi-spoke alloy wheel,

Rim diameter = 420mm

Rim width = 230mm

Center bore = 30mm

Bolt circles = 15mm

Spoke length = 200mm

4 DESIGN AND MODELLING:

4.1 6-SPOKE ALLOY WHEEL –

Fig 1 is the final designed model of the 6-spoke alloy and the fig 2 is the initial drawing of the 6-spoke alloy wheel.

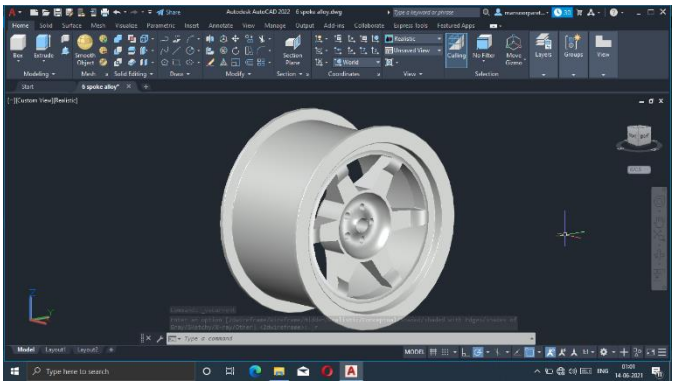

FIG-1: - FINAL DESIGNED MODEL OF 6-SPOKEALLOY

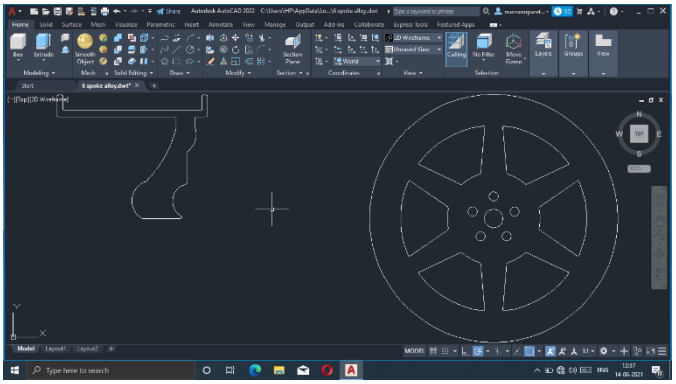

FIG-2: - INITIAL DRAWING OF 6-SPOKE ALLOY

4.2 MULTI-SPOKE ALLOY WHEEL –

Fig 3 is the final model of the multiple spoke alloy wheel and the fig 4 is the initial drawing of the multiple spoke alloy wheel.

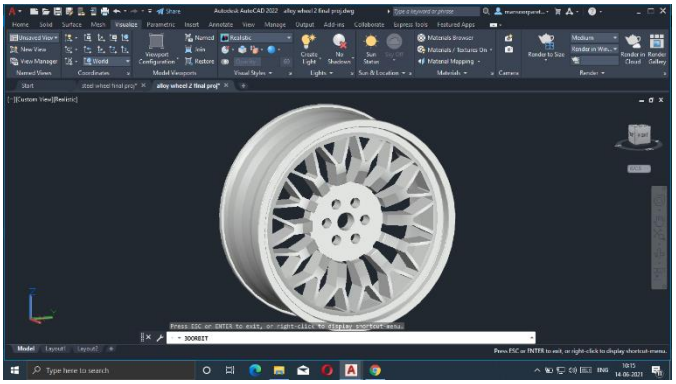

FIG 3: -DESIGNED MODEL OF MULTI-SPOKE ALLOY

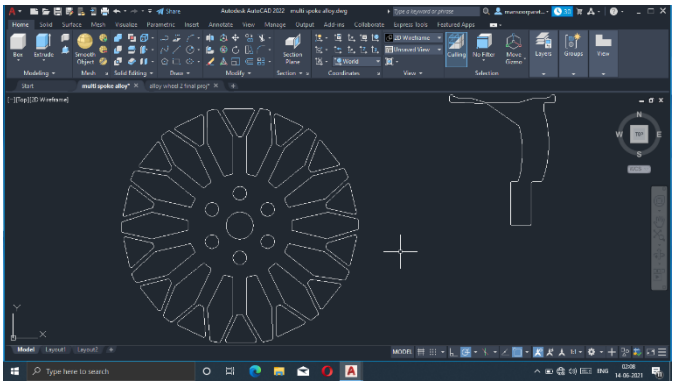

FIG: -INITIAL DRAWING OF MOLTI-SPOKE ALLOY

4.3 STEEL WHEEL –

Fig 5 is the actual designed and finalized model of the steel wheel and the fig 6 is the initial drawing of the steel wheel.

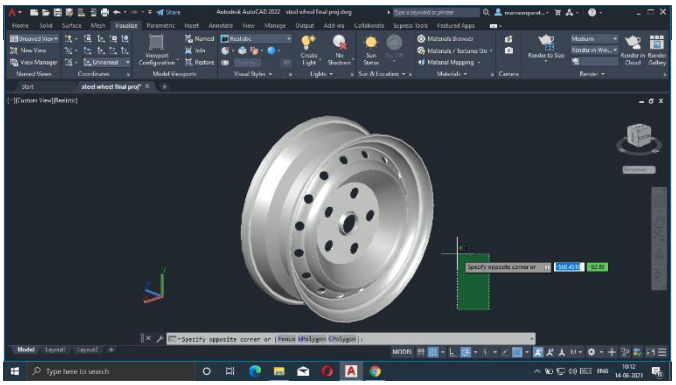

FIG 5: -FINAL DESIGNED MODEL OF STEEL WHEEL

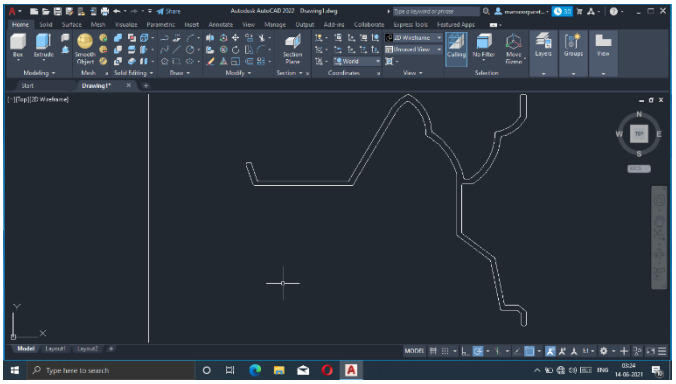

FIG 6: -INITIAL DRAWING OF STEEL WHEEL

5 MESHING:

Meshing is usually the first step done while doing analysis on the wheels. Meshing is done for reducing the time and effort required to get the actual results or the structural analysis of the wheels.

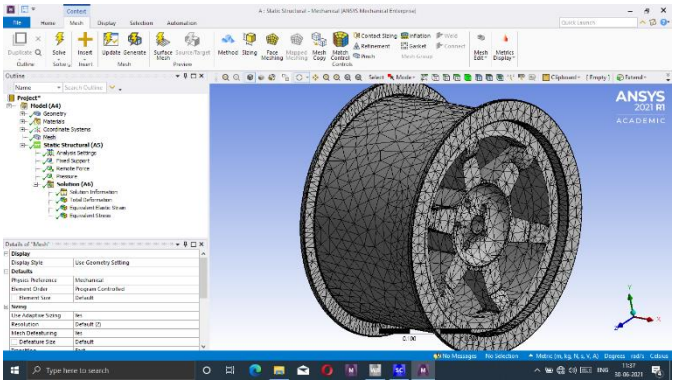

FIG 7: -MESHING OF 6-SPOKE ALLOY

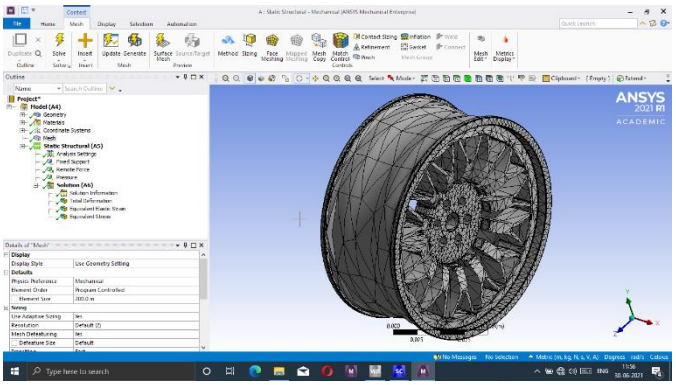

FIG 8:-MESHING OF MULTI-SPOKE ALLOY

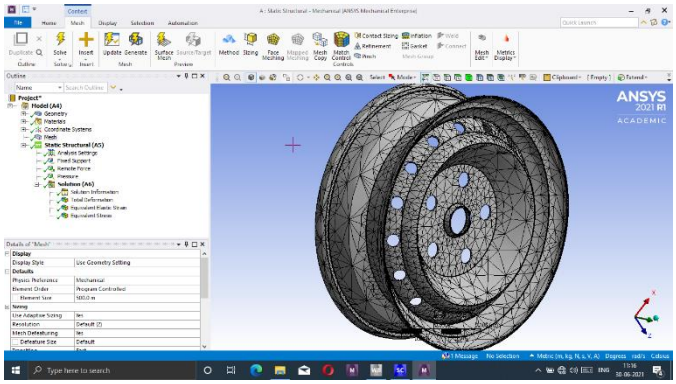

FIG 9: -MESHING OF STEEL WHEEL

6 ANALYSED MODELS:

6.1 6-SPOKE ALLOY WHEEL –

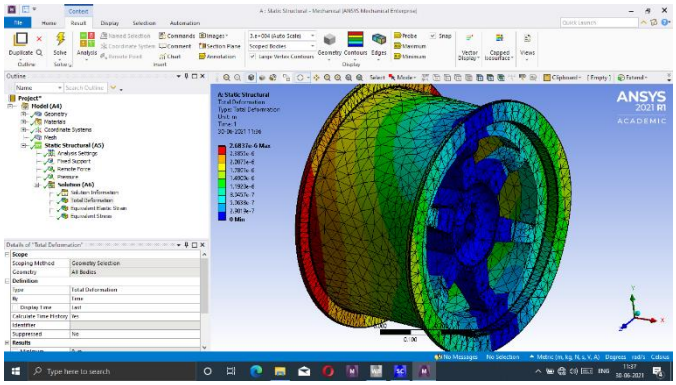

FIG 10: -TOTAL DEFORMATION

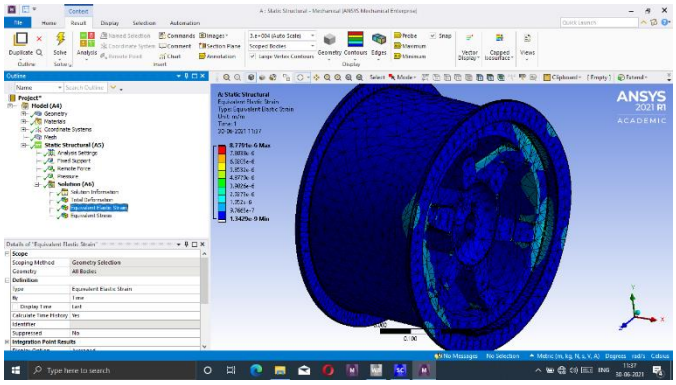

FIG 11: -EQUIVALENT ELASTIC STRAIN

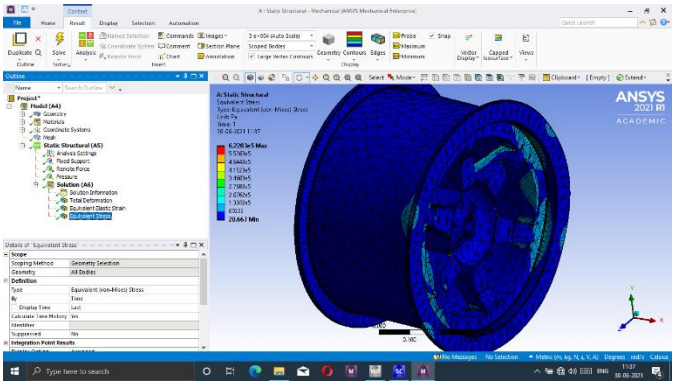

FIG 12: -EQUIVALENT STRESS

6.2 MULTI-SPOKE ALLOY WHEEL –

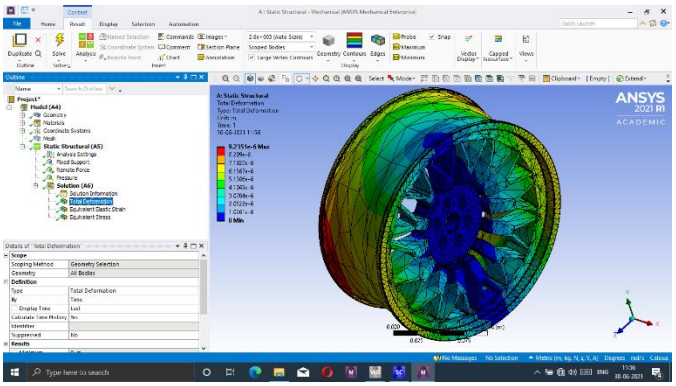

FIG 13: -TOTAL DEFORMATION

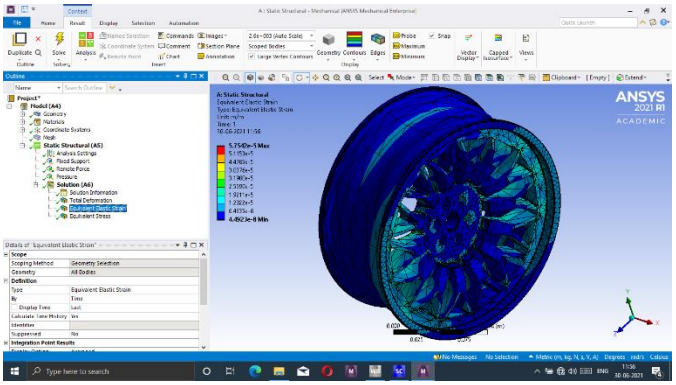

FIG 14: -EQUIVALENT ELASTIC STRAIN

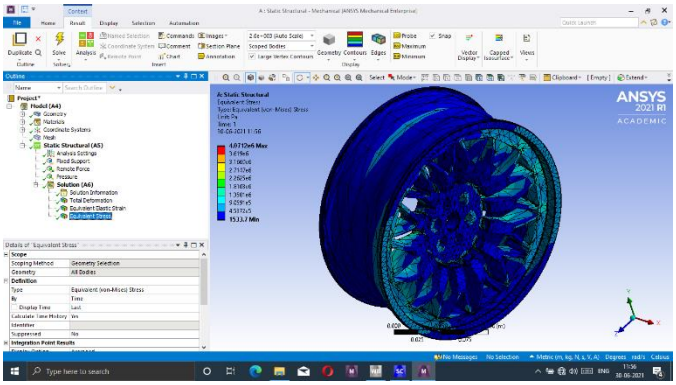

FIG 15: -EQUIVALENT STRESS

6.3 STEEL WHEEL –

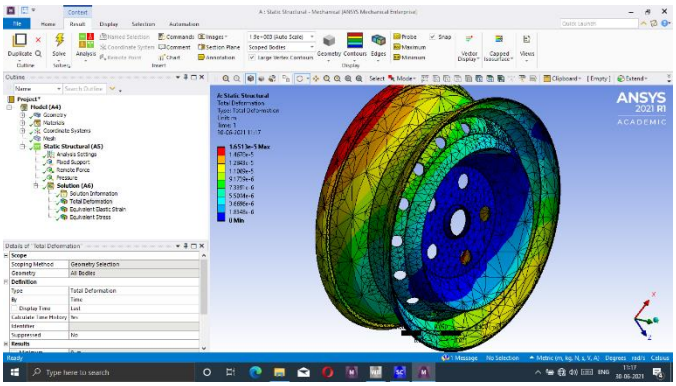

FIG 16: -TOTAL DEFORMATION

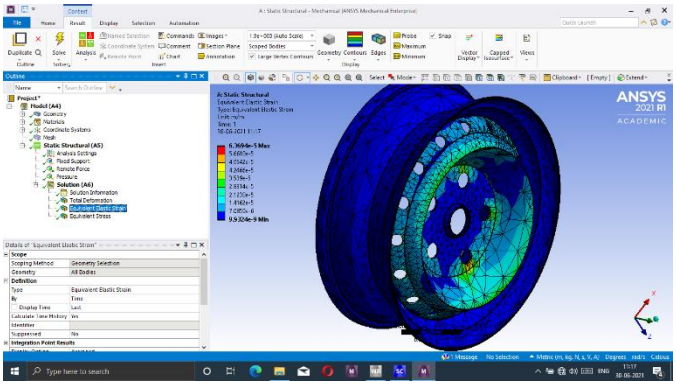

FIG 17: -EQUIVALENT ELASTIC STRAIN

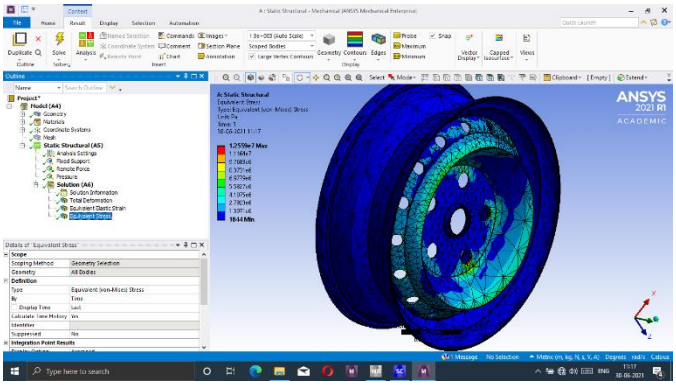

FIG 18: -EQUIVALENT STRESS

7 RESULTS :

TYPE OF WHEEL	MATERIAL	Max/min	EQUIVALENT STRESS (pa)	EQUIVALENT ELASTIC STRAIN (m/m)	TOTAL DEFORMATION (m)
6-SPOKE ALLOY WHEEL	Aluminium alloy	min	20.667	$1.35*10^{-9}$	0
		Max	$6.24*10^{5}$	$8.78*10^{-6}$	$2.69*10^{-6}$
MULTI-SPOKE ALLOY WHEEL	Aluminium alloy	min	1533.7	$4.5*10^{-8}$	0
		Max	$4.08*10^{6}$	$5.75*10^{-5}$	$9.25*10^{-6}$
STEEL WHEEL	Structural steel	min	1844	$9.95*10^{-9}$	0
		Max	$1.25*10^{7}$	$6.37*10^{-5}$	$1.65*10^{-5}$

8 CONCLUSIONS:

For the structural analysis for the remote force the magnitude applied is 1000N and for the pressure which applied on the wheel is 245kPa.

Therefore, so comparing the wheels with the total deformation occurred alloy wheels are better than the steel wheel, and comparing the both the alloy wheels multi-spoke alloy wheel is better than the 6-spoke alloy wheel.

Since the alloy wheel have some dis-advantages then also considering the results alloy wheels have better structural tendency than the steel wheels and if the spokes are better the tendency.

9 REFERENCES:

1) An analysis of stress and displacement distribution in a rotating rim subjected to pressure and radial loads, P.C. Lam and Srivastav

2) Stress Analysis of Wheel Rim International Journal of Mechanical Engineering and Research Volume 1 Issue 1, ISSN: 2277-8128.

3) Design and Analysis of Alloy Wheel, journal of V.R. Siddhartha Engineering College, Volume 4 Issue 6, ISSN:2395-0056 and ISSN:2395-0072.

4) Design and Comparative Analysis of old & New model car wheel Rims with Various materials, by Natrayan, IETE Journal of Research