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Design and Analysis of Alloy Wheel Rim by Using Different Material

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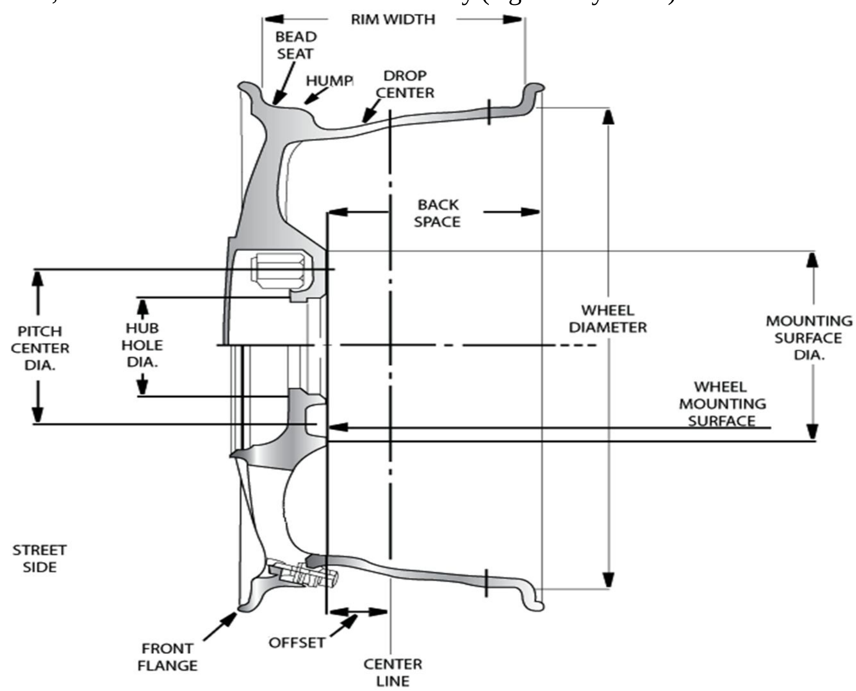
I. INTRODUCTION

The most punctual wheels were made of a strong bit of wood. In its crude frame, a wheel is a round square of a hard and strong material at whose middle has been drilled a roundabout opening through which is set a pivot bearing about which the wheel turns when a minute is connected by gravity or torque to the wheel about its hub, haggle along these lines making together one of the six basic machines. At the point when put vertically under a heap bearing stage or case, the wheel turning on the flat hub makes it conceivable to transport substantial burdens; when set on a level plane, the wheel turning on its vertical hub makes it conceivable to control the turning movement used to shape materials (e.g. a potter's wheel); when mounted on a section associated with a rudder or a suspension mounted on different wheels, one can control the course of a vessel or vehicle (e.g. a ship's wheel or directing wheel); when associated with a wrench, the wheel delivers or transmits vitality (e.g. the flywheel)



A. Preparation Of Alloy Wheel

Types Of Alloy Wheels

1) *Wire Spoke Wheel:* Wire talked wheel is a central where the outside edge some bit of the wheel (edge) and the turn mounting part are associated by various wires called spokes. The present autos with their high quality have made this kind of wheel make old. This sort of wheel is so far used on incredible vehicles. Light composite wheels have making starting late, an outline to offer emphasis to this spoke effect to fulfill customers frame requirements.
2) *Steel Disc Wheel:* This is a rim which hones the steel-made rim and the wheel into one by joining (welding), and it is utilized for the most part for traveller vehicles particularly unique gear tires.
3) *Light Alloy Wheel:* These wheels depend on the utilization of light metals, for example, aluminum and magnesium has come to be prevalent in the market. This wheel quickly winds up noticeably standard for the first gear vehicle in Europe in 1960's and for the substitution tire in United States in 1970's. The benefits of each light combination wheel are clarified as beneath

B. Production Of Alloy Wheels

Higher cars typically come with alloy wheels rather than basic steel wheels covered with cub hap, called mag wheels because when they are first came out they are made of alloy of magnesium. Today's alloy wheels are made with aluminium alloy, which is more durable. Aluminium alloys wheels are not only more attractive than standard steel wheels; they are also the fraction of their weight. And therefore require less energy to rotate; this contributes to greater fuel efficiency, as well as better handling acceleration and breaking. Manufacturing begins with high grade aluminium alloy, containing 97%Al. A furnace heats the ingests to 750oC. They liquefy in about 25min. The molten Al then flows directly to a mixer in which they inject argon gas which enables them to remove the hydrogen; this increases the density making the Al less porous when solidified. After adding powder titanium, mg, and other metallic elements to further strengthen the Al they blend in flux, a material which draws aluminium oxide to the surface.

II. MATERIAL

Wide varieties of materials are available in the market can be used for wheel rims. In ancient period wheel rims are manufactured from single piece wooden material, after some millennium metals are evolved and a circular ring are mounted over wooden spoke wheel rim in order to avoid the wear of wheel due to road surface. At the end of eighteenth century a wire spoke wheel rims was used in an automobile after evolution of first engine and car. Wire spoke wheels used up to 1920. After First World War rim design revolution takes place and wire spoke wheels replaced by a sheet metal and casted wheel rims. However rim manufacturing process changed its testing methods as well as basic design requirements are same yet. Now a day following materials are generally used for wheel rim: Al alloys, Mg alloys, Steel 1008, forged steel, Carbon fibers.

Apart from mechanical properties there are some important factors must be considered while selecting a material for wheel rim. We have taken four different types of materail in our project such as, aluminium alloy, Magnesium alloy, Titanium Alloy, Forged steel alloy.

A. Aluminium Alloy

Aluminium is a metal with features of excellent lightness, thermal conductivity, rust confrontation, physical characteristics of casting, low heat, machine processing and reutilizing, etc. This metals main advantage is decreased weight, high precision and design choices of the wheel. This metal is useful for energy preservation because it is possible to re-cycle aluminium easily.

B. Magnesium Alloy

Magnesium is about 30% lighter than aluminium and also admirable as for size stability and impact resistance. However, its use is mainly restricted to racing, which needs the features of weightlessness and high strength at the expense of weathering resistance and design choice, etc. compared with aluminum.

III. DESIGN, ANALYSIS & RESULTS OF WHEEL RIM

A. Design Consideration of Wheel Rim

Apart from mechanical properties there are some important factors must be considered while selecting a material for wheel rim. Other design consideration includes Heat Dissipation, style and weight, dimensional tolerances and corrosion resistance. Rim material should be as light as possible so that unsprung weight gets directly reduced. Following properties should be considered while designing the Wheel rim.

1) *Stiffness:* Structural stiffness (design dependent) is the basic value to consider when designing an aluminium wheel to achieve at least the same vehicle behaviour as with an equivalent steel wheel.However, material stiffness (Young's modulus) is very little depending on alloy and temperature.
2) *Static Behaviour:* Yield strength is considered to avoid deformation under maximal axial efforts (accelerations and braking) and radial ones (plus turning). Misuse cases are considered in relation to tensile strength. Yield tests under pressure are also conducted to check this behaviour.
3) *Fatigue Behaviour:* This is the most important parameter for dimensioning. Finite element software is systematically used during design. Service stresses are considered, including multi-axial stresses as of recently. Rotary bending and rim rolling tests are used to verify these calculations.
4) *Crash Worthiness:* Mainly, but not only, linked to stress/strain curves in large displacements. Crashworthiness is beginning to be now simulated. However impact tests systematically check the resistance to accidental collisions such as pavements impacts.

5) *Cooling:* Whatever the type of wheel (cast, forged, strip, mixed wrought-cast), aluminium dissipates heat more quickly than steel. Further, aluminium wheels act as a very efficient heat sink. This results in significant improvements of braking efficiency, and a reduced risk of tyre overheating.
6) *Style: Weight Saving:* Reduction of weight of the unsprung mass of vehicles is a key priority. A compromise has to be accepted if styling requirements dictate different production technologies (s. figure).
7) *Dimensional:* A perfect mass balance is a key parameter to avoid significant vibrations. As a result, cast and forged wheels are machined. Lightness also reduces vibrations of aluminium sheet wheels
8) *Corrosion:* Cast and forged wheels are painted or lacquered after chemical conversion. Strip wheels are polished and varnished or also painted. Even at the uncoated iron/aluminium disk, or hub interface, no significant corrosion has ever been noticed for any

B. Design of Automobile Wheel Rim

In the modeling of the passenger car wheel rim, it have been taken the rim from 60 series 195/60 R 14.

SR.NO.	Parameters Taken For Modeling	
1	Rim Nomeclature	7 -JJ-14 50 5 96.0
2	Flange Shape	JJ
3	Rim Diameter	15 inch
4	Rim Width	8 inch
5	Offset	72mm
6	Pitch Circle Diameter	96mm
7	Hub Diameter	46mm
8	Number Of Bolt Holes	5 nos
9	Number of Spokes	5 nos

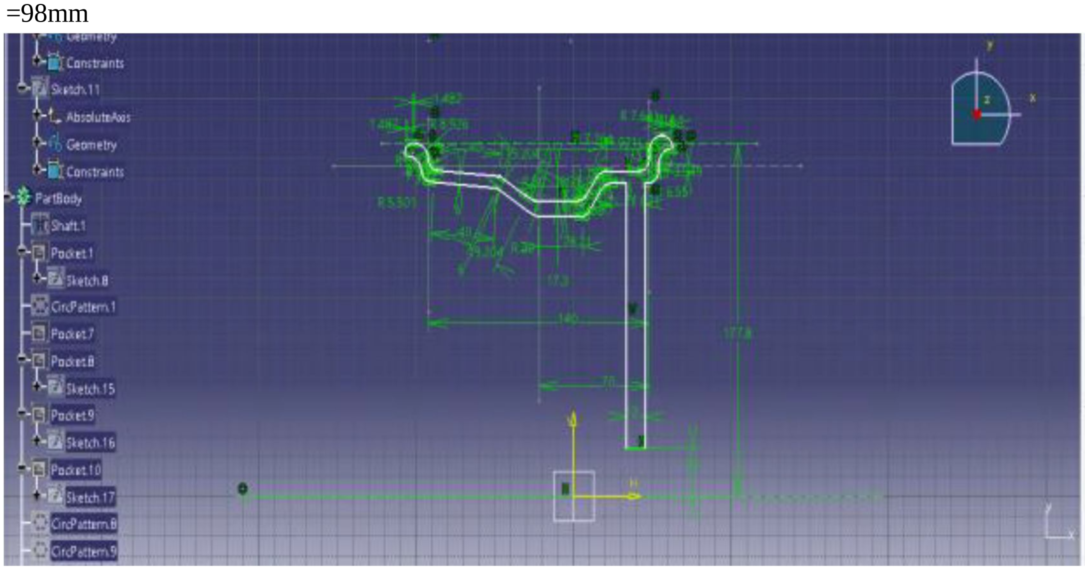
C. Parameters for Modeling Wheel Rim

The flange height, rim width, bead seats and rim diameter are taken with standard dimensions.

If the diameter of the hub is taken as 48 mm and the prime circle is taken as 25mm. The pitch circle diameter can be calculated as

25 x 2 + 48 PCD

Therefore PCD =98mm



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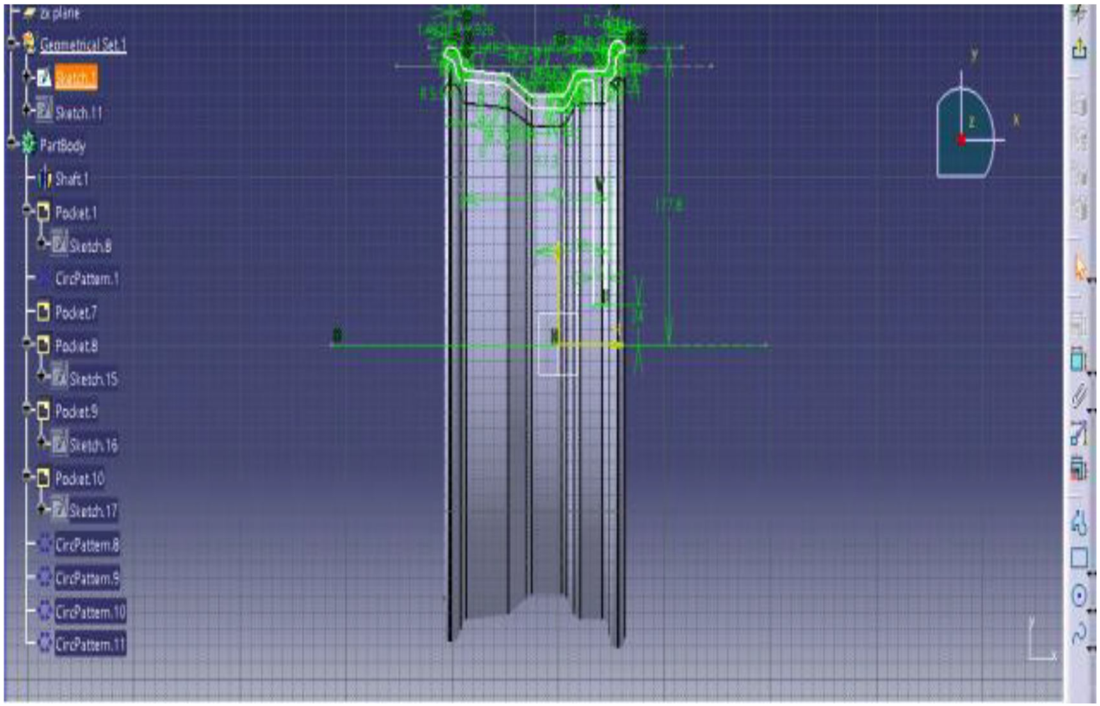
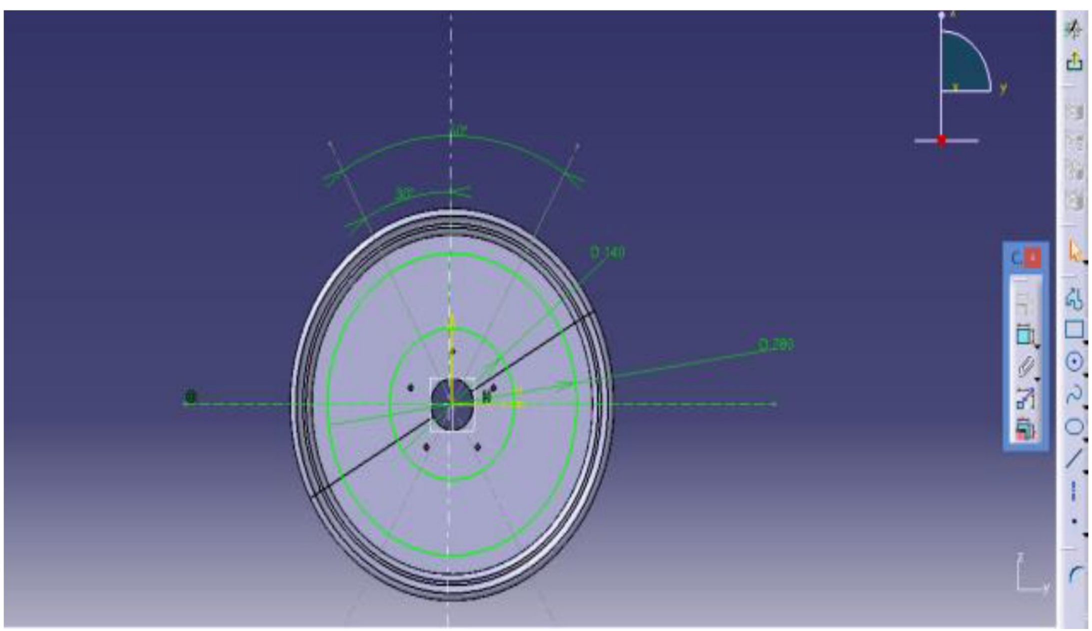
D. Modeling of Wheel Rim with J Contour



Front View of Wheel Rim

The above figure shows the front view of the wheel rim. There is a clear view of the J counter and shaft operation is performed. The total diameter of the wheel rim is 355.6mm. The diameter is taken as per the continental data book.
The pitch circle diameter taken is 5×98. Where 5 indicate the number of bolt holes and 98mm indicates the pitch circle diameter drawn. On the P.C.D the bolt holes are modeled for a wheel.

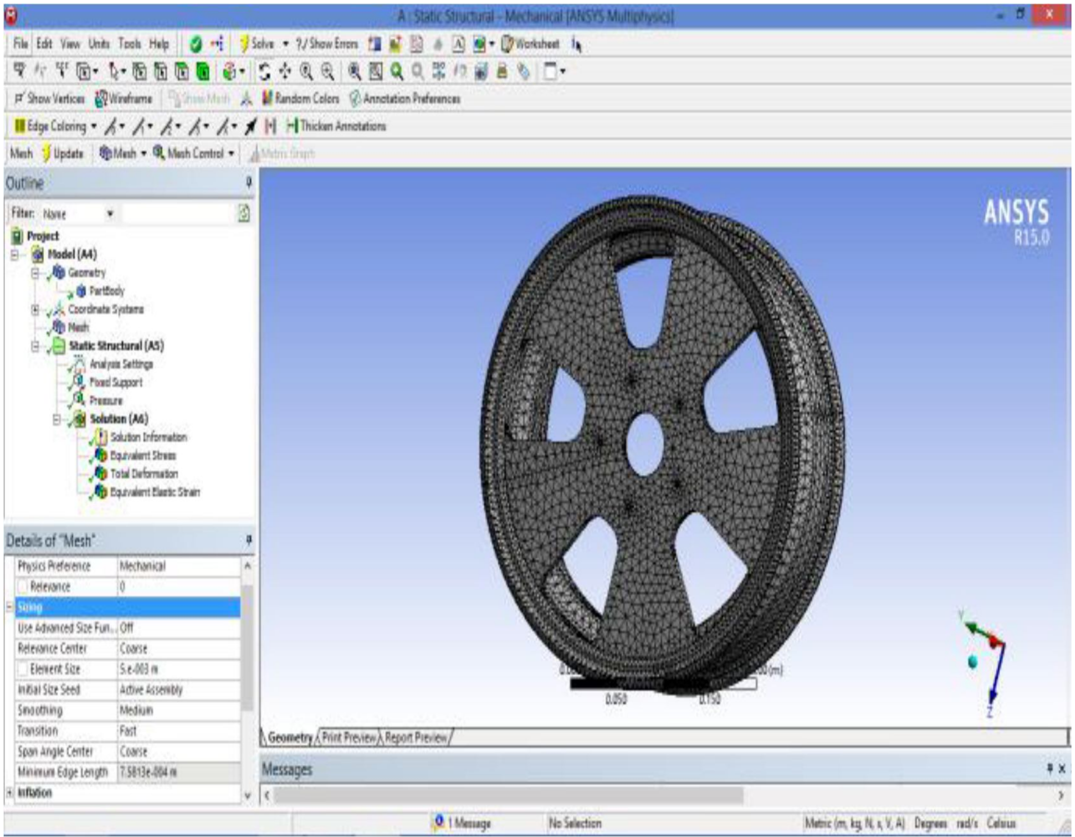


Modeling Of Spoke Design

For the five bolts design and to model four spokes on the disc surface certain angles are taken. Total disc of 3600 made into equidistant parts and the spokes are drawn with an angle of 300.

E. Meshing

The imported file geometry undergoes meshing after which boundary conditions are applied to the physical domain. The fine mesh is considered for good results.



Meshing of Wheel Rim

After the processing stage the boundary conditions are applied on the wheel rim. The loads are applied. As we seen earlier, the designed wheel rim is with the load index 86 i.e., it has the capacity to bear 530 kg. The load given here is 5200N. But here the wheel rim is considered as it is in static condition. When the car is in stationary, the entire load on the wheel rim will be distributed throughout the rim because of the air. The air is a medium which circulates the entire force acting on the rim.

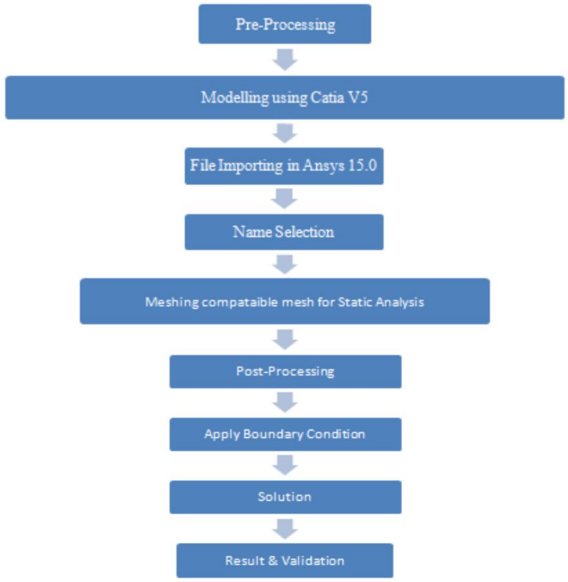
F. Methodology of an Alloy Wheels

Reason for Selecting Lighter Materials

The material selections for wheel rim are light alloys and composite material, as the lighter materials reduce the weight of wheel saves material cost and increase the mileage of the vehicle.

Reason for choosing these materials are not only for the reduction of weight of the rim, but also the considerable performance benefits, they are;

1) *Reduced Unsprung Weight:* The term Sprung weight is used to portray the parts of a vehicle that are bolstered by the front and rear springs. They hang up the body, frame, engine, all fluids and the power train over the wheels. These are entirely substantial assemblies. Whereas Unsprung weight incorporates the auxiliary members not upheld by the springs such as tyre and rim, brake and rear axle assemblies and other.[6] This typically incorporates some rate of weight of the suspension itself. It is an important concept because of lessening unsprung weight, wheels give more precisesteering and enhanced rotation attributes.
2) *Response on Acceleration and Braking:* Wheels give more response on speeding up and braking, due to reduction in rotational mass of the vehicle
3) *Brake Cooling is Increased:* The materials of light alloy and composites will reduce the danger of fade under rash 24riving, because of its brilliant heat conduction and enhanced heat dissipation from the brakes.

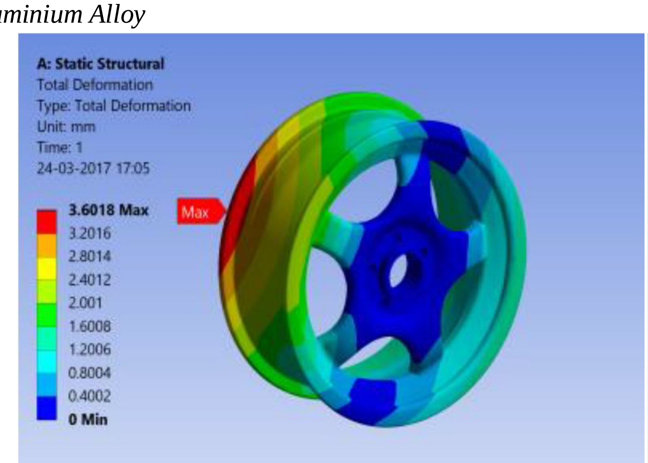


Steps of Working

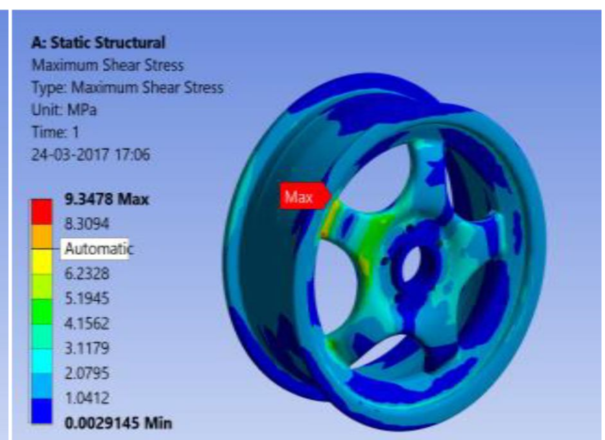
IV. ANSYS MODELS

A. Basic Design

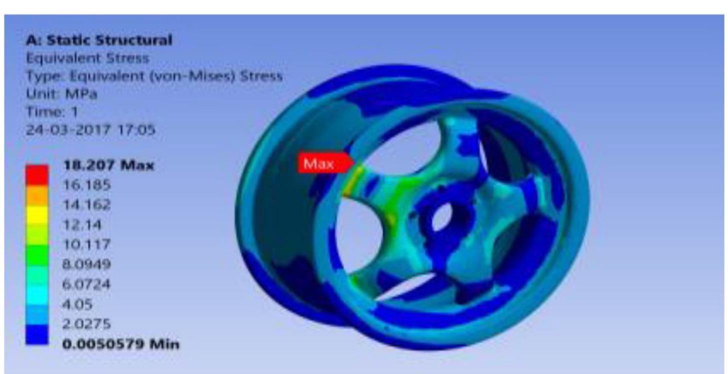
1) Aluminium Alloy



A] Total Deflection

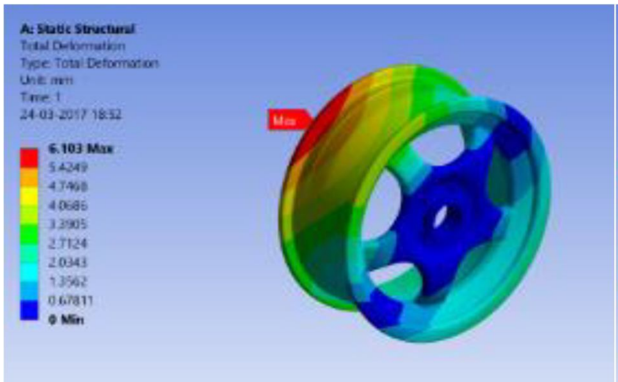


B] Maximum shear stress

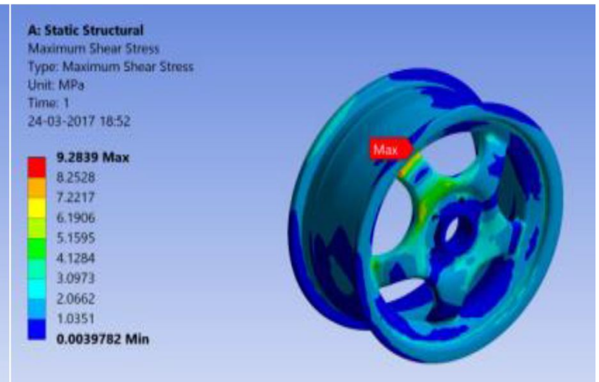


C] Equivalent Stress

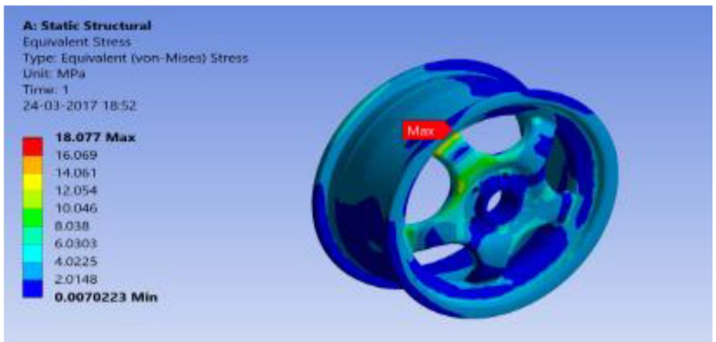
2) Magnesium Alloy



A] Total Deflection



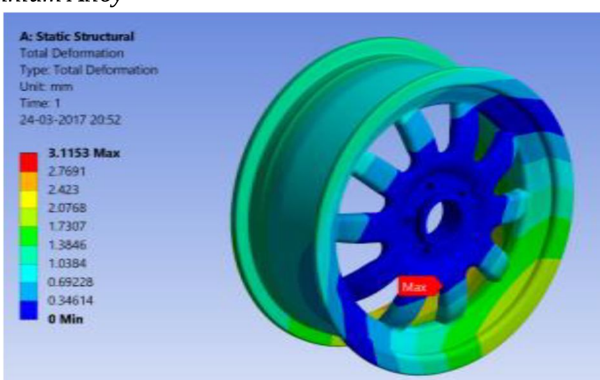
B] Maximum shear stress



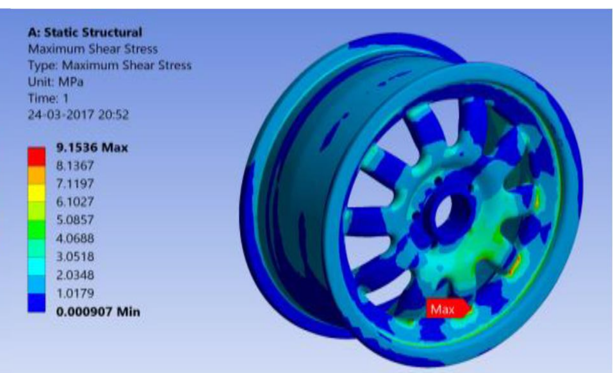
C] Equivalent Stress

B. Simple Model

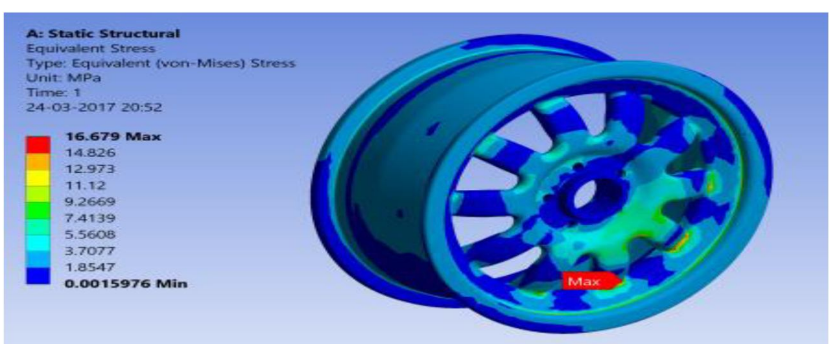
1) Aluminium Alloy



A] Total Deflection

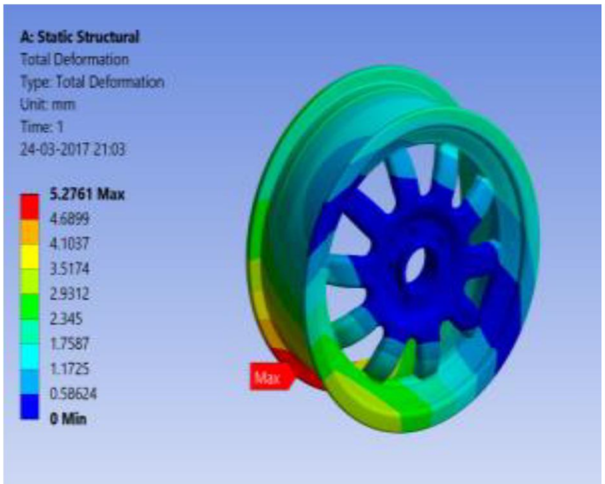


B] Maximum shear stress

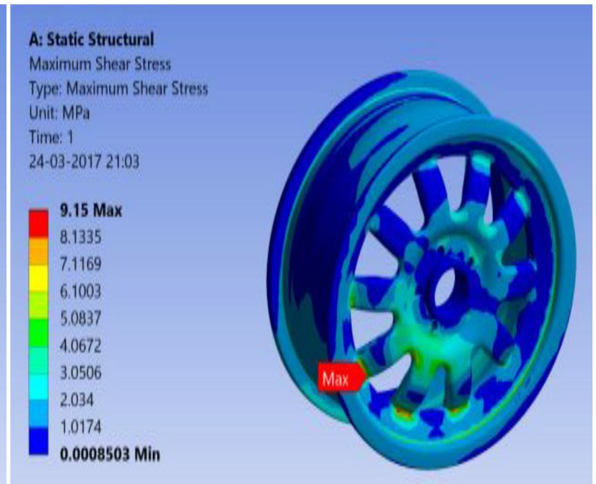


C] Equivalent Stress

2) Magnesium Alloy



A] Total Deflection



B] Maximum shear stress

C] Equivalent Stress

C] Equivalent Stress

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V. RESULTS AND COMPARISION

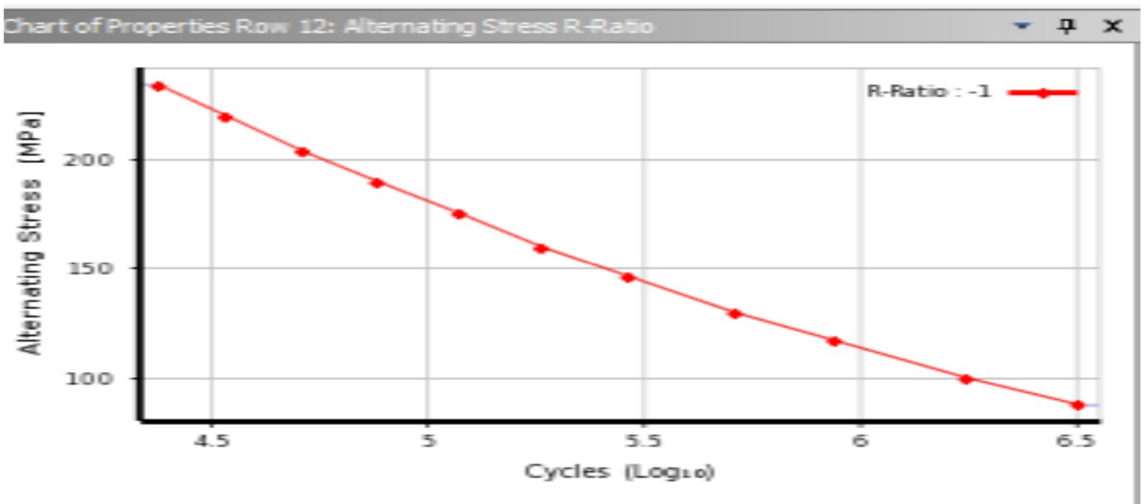
Analysis is done on imported design from CATIA V5 using static structural and modal analysis workbench under required condition, on different alloy and composite materials. The results are obtained and compared between different materials under same parametric conditions.

PROPERTIES	Aluminium alloy	Magnesium alloy
Total Deformation	0.13156 mm	0.13505 mm
Equivalent Elastic Strain	5.2416e-004 mm/mm	5.3669e-004 mm/mm
Equivalent stress	37.147 MPa	24.104 MPa

Result and Comparision

When comparing between alloy materials aluminium alloy has better deformation factors and better strain coefficients But when alloy materials is compared to composite material, composite material has better deformation and stress factors.

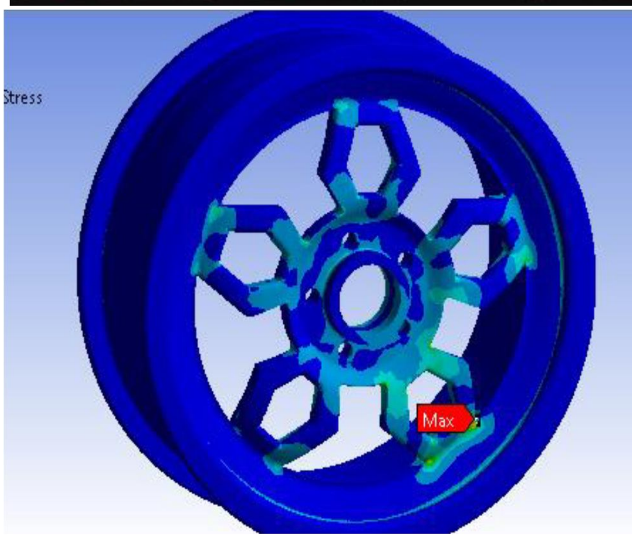
A. Graphical Representation of Static Analysis



	B	C
1	Cycles	Alternating Stress (MPa)
2	24076	234.12
3	34527	220
4	51601	204
5	77110	190
6	1.1886E+05	175.59
7	1.8509E+05	160
8	2.9425E+05	146.32
9	5.1319E+05	130
10	8.7774E+05	117.06
11	1.7667E+06	100
12	3.2E+06	87.76

VI. PRACTICAL FAILURE CASES

Comparing the theoretically most stressed areas of wheel rim (obtained from ansys software) with practical failed cases

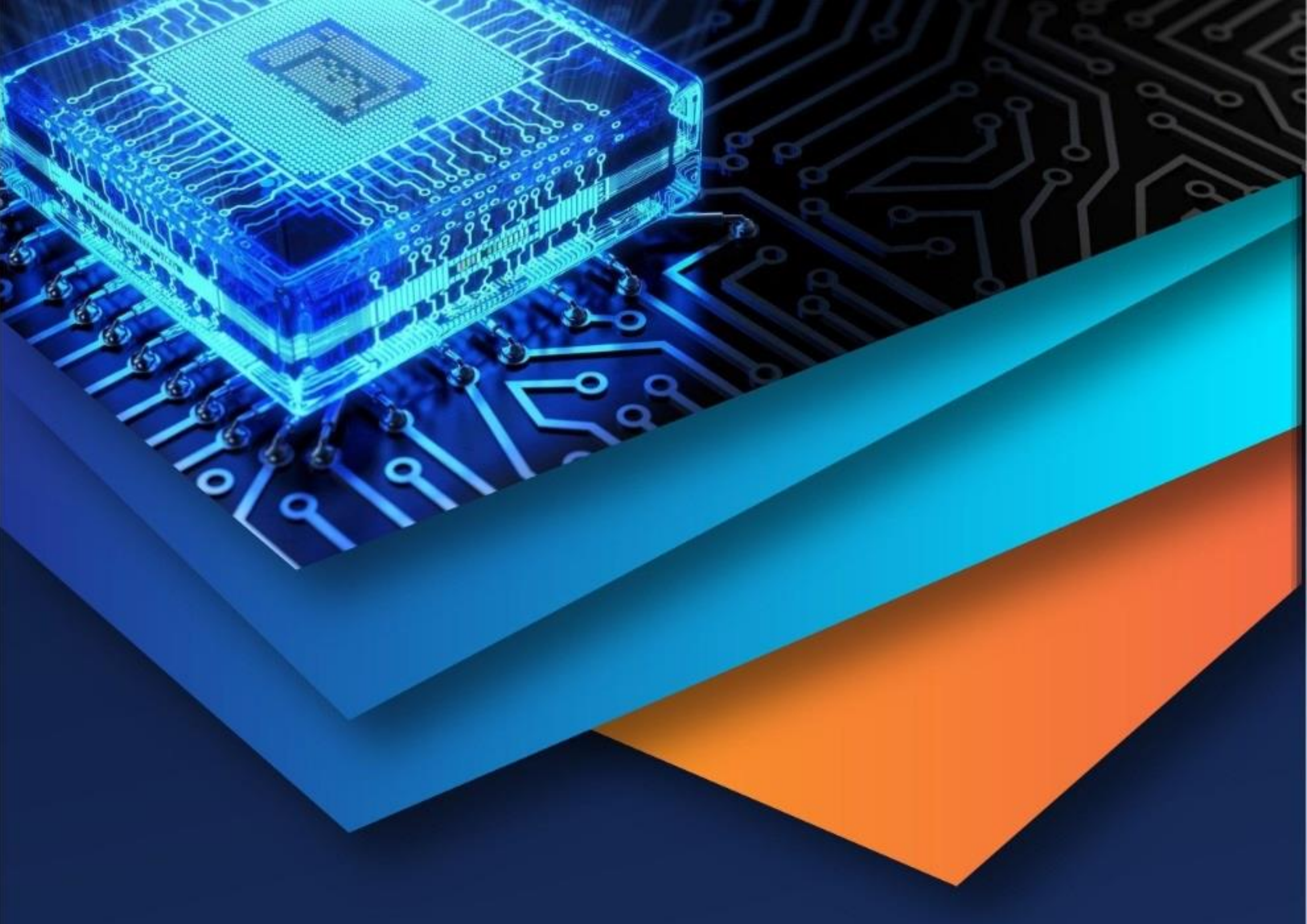


VII. CONCLUSIONS

1) From the analysis we came to know that all the four designs are safe and are within the standard limits Among the four designs simple rim design is more promising than centrifugal rim Followed by pentagonal rim Among the four materials steel alloy is the best material followed by aluminium and magnesium occupies last position as it has more deformation for the same loading condition.
2) From this results we can then why magnesium alloy material is only used for pretty shorter period restricted to racing cars only From the fatigue analysis aluminium alloy has got more life than that of the steel alloy Even though the safety factor is almost equal for both the materials aluminium is subjected to less damage compared to steel (for same loading conditions) From the above results we define a new material (Al-Mg alloy) which is more promising than other.

REFERENCES

[1] V.Karthi et, al., "Design and analysis of alloy wheel rim" International Journal of Innovative Research in Science, Engineering and Technology An ISO 3297: 2007 Certified Organization Volume 3, Special Issue 2, April 2014.
[2] Daniel Antony C et,al., "Design and Analysis of Two Wheeler Alloy Wheel Rim Using Composite Materials". International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 5, May 2016.
[3] G.Ashokkumar et, al., "Design and analysis of wheel rim by using CATIA & ANSYS". International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 12 | Dec -2016 e-ISSN: 2395 -0056 p-ISSN: 2395-0072
[4] Gudise Venkateswarlu et, al., "Design and analysis of alloy wheel with different alloys". International journal of advance research in science and engineering volume no 06 issue no 10, Octomber 2017.



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