Development and Analysis of Wheel Rim by Using 3 Different Materials Al-2024, Al-6061 And Znal4

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ABSTRACT

The importance of wheels and tyres in the automobile is obvious. Without the engine the car may be towed but even that is not possible without wheels. The wheel along with tyre has to take the vehicle load, provide a cushioning effect and cope up with the steering control

The rim is the "outer edge of a wheel, holding the tire". It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles. For example, on a bicycle wheel the rim is a large hoop attached to the outer ends of the spokes of the wheel that holds the tire and tube. The term rim is also used non-technically to refer to the entire wheel, or even to a tire.

In this project we designed one wheel rim with existing dimensions by using cad tool solid works and analysed with cae tool (Ansys workbench) calculated results for 5 members weight loading conditions. Here comparing both 5 spokes and 6 spokes results with 3 different materials al-2024, al-6061, Znal4, finally conclude which material/model is optimum and why it is.

Tools were used:

Cad tool: solid works

Cae tool: ansys workbench

1. Introduction

WHEEL:

The importance of wheels and tyres in the automobile is obvious. Without the engine the car may be towed but even that is not possible without wheels. The wheel along with tyre has to take the vehicle load, provide a cushioning effect and cope up with the steering control. The various requirements of an automobile wheels are:

- 1. It must be strong enough to perform the above functions.
- 2. It should be balanced both statically as well as dynamically.
- 3. It should be as light as possible so that the unsparing weight is least.
- 4. It should be possible to remove or mount the wheel easily.

- 5. Its material should not deteriorate with weathering and age. In case the material is susceptible to corrosion, it must be given suitable protective treat

RIM:

The rim is the "outer edge of a wheel, holding the tire". It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles. For example, on a bicycle wheel the rim is a large hoop attached to the outer ends of the spokes of the wheel that holds the tire and tube. The term rim is also used non-technically to refer to the entire wheel, or even to a tire.

In the 1st millennium BC an iron rim was introduced around the wooden wheels of chariots.

- **Diameter**: distance between the bead seats (for the tire), as measured in the plane of the rim and through the axis of the hub which is or will be attached, or which is integral with the rim.
- **Width**: separation distance between opposed rim flanges. The flange-to-flange width of a rim should be a minimum of three-quarters of the tire section width. And the maximum rim width should be equal to the width of the tire tread.
- **Type**: Depends on the type of vehicle and tire. There are various rim profiles, as well as the number of rim components.

Modern passenger vehicles and tubeless tires typically use one-piece rims with a "safety" rim profile. The safety feature helps keep the tire bead held to the rim under adverse conditions by having a pair of safety humps extending inwardly of the rim toward the other tire bead seat from an outer contoured surface of the rim.

Heavy vehicles and some trucks may have a removable multi-piece rim assembly consisting of a base that mounts to the wheel and axle. They then have either a side ring or a side and lock ring combination. These parts are removable from one side for tire mounting, while the opposite side attached to the base has a fixed flange.

- **Vehicle performance**: Because the rim is where the tire resides on the wheel and the rim supports the tire shape, the dimensions of the rims are a factor in the handling characteristics of an automobile. For example:
- Overly wide rims in relation to the tire width for a particular car may result in more vibration and less comfortable ride because the sidewalls of the tire have insufficient curvature to flex properly over rough driving surfaces. Oversized rims may cause the tire to rub on the body or suspension components while turning.
- Overly narrow rims in relation to the tire width may cause poor handling as the tire may distort sideways under fast cornering. On motorcycles, a narrow rim will alter the tire profile, concentrating tire wear in a very small area during

cornering, with a smaller contact patch during braking.

Literature review

Sasank Shekhar Panda, Jagdeep Gurung, Udit Kumar Chatterjee, Saichandan Sahoo (2016) [1] had represented the car wheel rim provides a firm base on which to fit the tire. Its dimensions, shape should be suitable to adequately accommodate the particular tire required for the vehicle. In this study a tire of car wheel rim belonging to the disc wheel category is considered. The wheel rim is designed by using modeling software catiav5r18. In modeling the time spent in producing the complex 3-D models and the risk involved in design and manufacturing process can be easily minimized. So the modeling of the wheel rim is made by using CATIA. Later this CATIA model is imported to ANSYS for analysis work. ANSYS software is the latest used for simulating the different forces, pressure acting on the component and also for calculating and viewing the results. A solver mode in ANSYS software calculates the stresses and their relations without manual interventions, reduces the time compared with the method of mathematical calculations by a human. ANSYS static analysis work is carried out by considered two different materials namely aluminum and Magnesium alloy and their relative performances have been observed respectively. In addition to this rim is subjected to vibration analysis (modal analysis), a part of dynamic analysis is carried out its performance is observed.

Wheel rim specifications

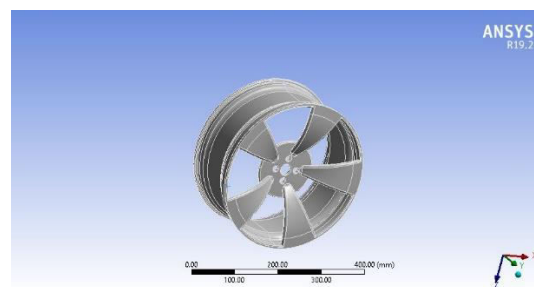|	
Wheel rim main diameter	480mm
Wheel rim width	250mm
Shaft diameter	35mm
Bolt diameter	15mm
No of spokes	5/6
Wheel rim thickness	10mm
Pitch circle diameter	160mm
No of bolts	4

Designs
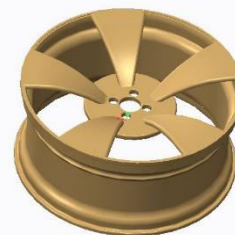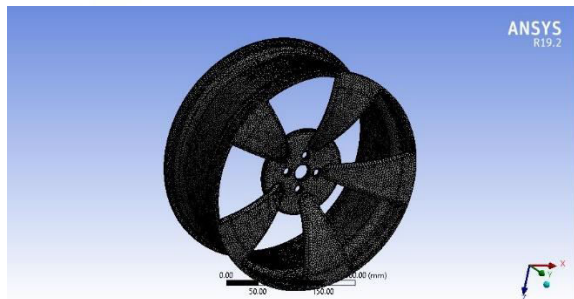

5 spokes wheel rim
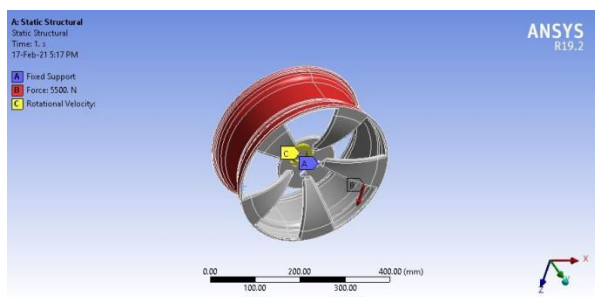

6 spokes wheel rim

Ansys process

Meshing

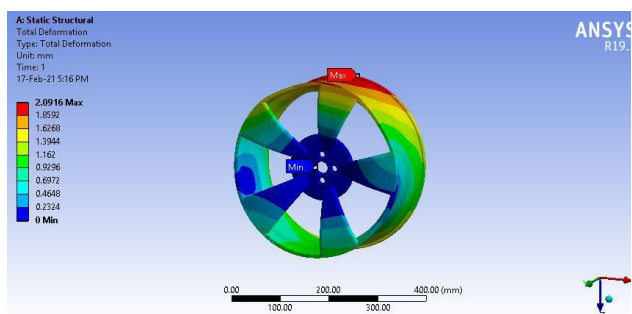**5 members loading Boundary conditions**

Select force and select required area to be applied, and enter force value as 5500N, and then select fixed supports and select center holes, and then apply rotational velocity as 2400RPM, and then solve
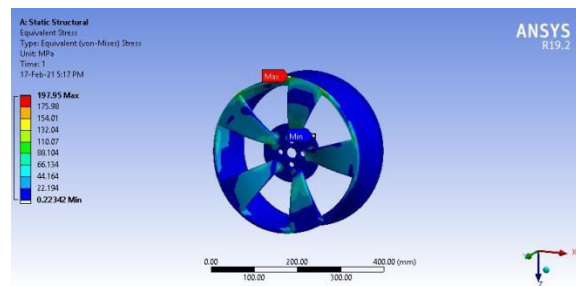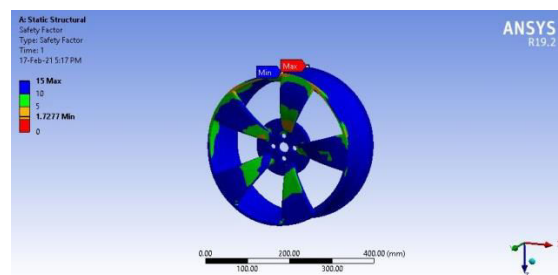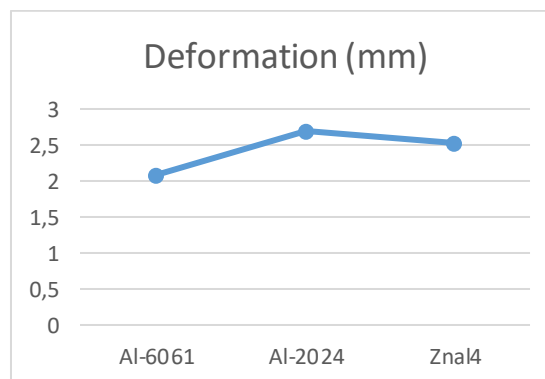
Results

Al-6061

Deformation

Stress

Safety factor

Tables

5 spokes wheel rim	Al-6061	Al-2024	Znal4
Deformation (mm)	2.0916	2.6902	2.5284
Stress (Mpa)	197.95	152.12	151.76
Strain	0.0020991	0.0022304	0.0020928
Safety factor	1.7277	1.8736	2.1086

Graphs

Stress (Mpa) — graph: Al-6061, Al-2024, Znal4

Safety factor

Safety factor — graph: Al-6061, Al-2024, Znal4
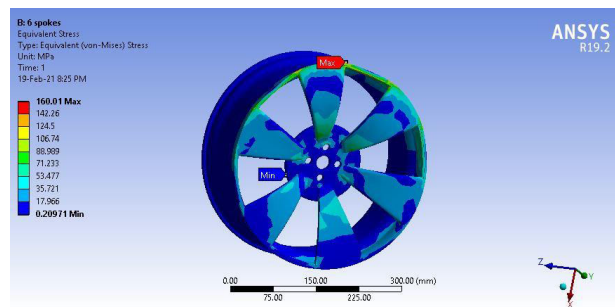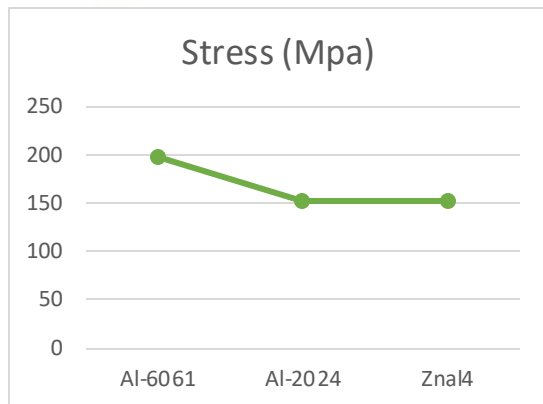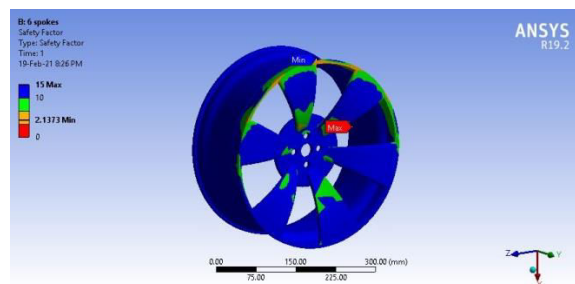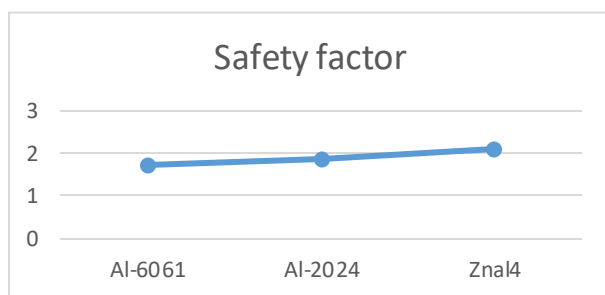
6 spokes wheel rim

Results

Al-6061

Deformation
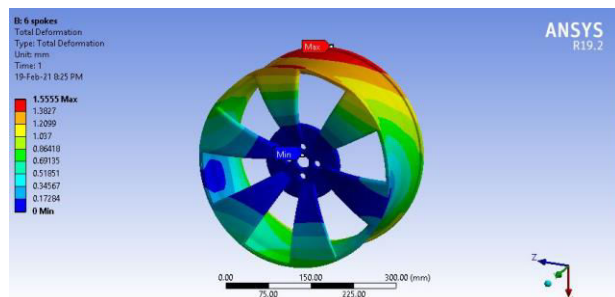
Stress

Tables

6 spokes wheel rim	Al-6061	Al-2024	Znal4
Deformation (mm)	1.5555	1.9845	1.8648
Stress (Mpa)	160.01	118.75	118.42
Strain	0.0016894	0.0017325	0.0016249
Safety factor	2.1373	2.4	2.7022

Graphs

Deformation (mm) — graph: Al-6061, Al-2024, Znal4

Stress (Mpa)

Safety factor
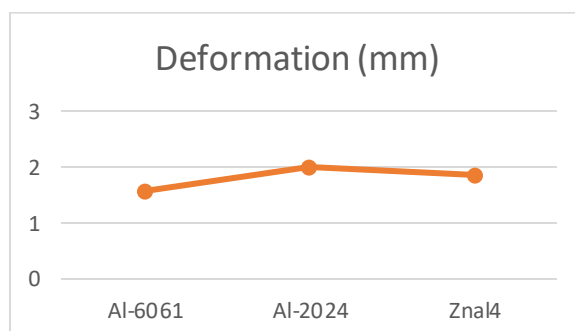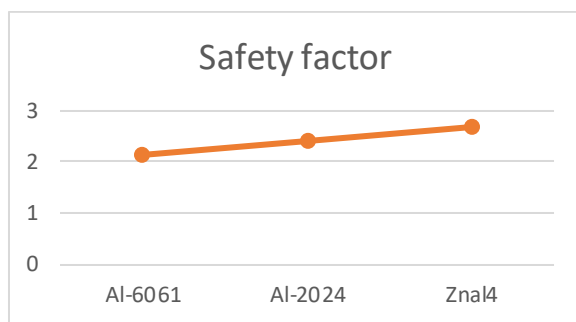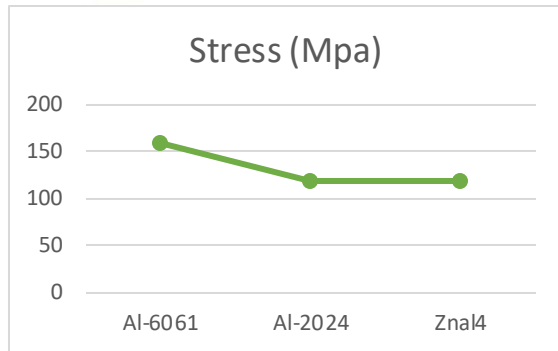
Dynamic analysis results

5 spokes wheel rim	Al-6061	Al-2024	Znal4
Mode1 (Hz)	102.36	102.22	103.18
Mode2 (Hz)	102.47	102.32	103.28
Mode3 (Hz)	206.46	206.13	208.15
Mode4 (Hz)	224.39	223.6	226.84
Mode5 (Hz)	254.41	254.76	255.46
Mode6 (Hz)	254.68	255	255.75

6 spokes wheel rim	Al-6061	Al-2024	Znal4
Mode1 (Hz)	118.86	118.93	119.72
Mode2 (Hz)	119.91	120.14	121.01
Mode3 (Hz)	244.36	244.81	246.44
Mode4 (Hz)	259.39	259.85	260.16
Mode5 (Hz)	259.96	260.23	260.81
Mode6 (Hz)	262.67	262.63	266.52

Conclusion

In this project we designed two wheel rims(5 spokes, 6 spokes) with existing dimensions by using cad tool solid works

and analysed with cae tool (Ansys workbench) calculated results for 5 members weight loading conditions.

In this process we applied boundary conditions on each model separately, i.e. when car is moving with 5 members, we applied forces acting on the body and also rotational velocity, by these boundary conditions calculated deformations, stress, strain, and safety factor values respectively. From these results concluding that which material has very less stressed with good amount of safety factor values even though high amount of boundary conditions acting on it.

By knowing static and dynamic analysis results, both al-2024 and znal4 materials are having better results than al6061 material, and the both materials can reduce the stress value on the object, finally thesis can conclude here with znal4 material is suggested for this automobile wheel rim to improve the static and dynamic performance

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