

Modelling and analysis of Wheel rim in MUV vehicle using CAD/CAE tools

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ABSTRACT

The "rim" refers to the "outer edge of a wheel that retains the tyre," as defined by Merriam-Webster. It is the portion of the wheel that has an exterior circular design and acts as the mounting place for the inner edge of the tyre on automobiles and other kinds of vehicles, such as trucks and cars. Its primary function is to protect the wheel from damage. The rim of a bicycle wheel, which is essentially a large hoop attached to the outermost ends of the wheel's spokes and serves as a container for the tyre and the tube, is a good example of this idea. When seen from a cross-section, the rim is deepest in the middle and tapers out toward the outer corners. In this paper, the wheel rim of a Kia carnival premium vehicle is modelled and analysed with the use of cad/cam software. After being built with the help of solid works, the item was analysed using both structural and dynamic boundary conditions. In addition, a material that is capable of withstanding high speeds and maximal loads has been proposed as a boundary condition. Materials al-7075 and al-7068 were selected for the investigation in this particular instance, and a Kia carnival premium vehicle was selected as the subject of the investigation. The boundary conditions comprised a variety of loads, ranging from a minimum of three members to a maximum of nine members. The highest number of members was nine. In conclusion, the most finest material that could possibly be used for the paper.

Keywords: CAD/CAE, Kia, Wheel Rim

INTRODUCTION

Archaeologists and historians of today generally agree that the invention of the wheel was the true starting point for any ancient civilisation. The wheel was by far the most important thing to be discovered in ancient times. Originally just larger bearings, wheels have evolved over time to become an essential component of all modern modes of transportation. In order to protect the well-being of people who travel in modern automobiles, the manufacturing process is subject to highly stringent guidelines.[1-3]

Steel, as well as non-ferrous alloys such as magnesium and aluminium, may be used in the production of these wheels, which

have reached a level of sophistication that is comparable to the materials used. Wheels for automobiles have come a long way from their early iterations, which had spokes made of wood and steel. Modern automobiles use new cast and forged aluminum alloy rims and stamped metal configurations. Since the 1970s, various novel approaches to evaluating wells that are assisted by experimental stress measurement have been introduced. In recent years, the processes for structural analysis have been enhanced thanks to the use of a wide range of experimental and analytical methodologies (finite element method). The vehicle wheel has been subjected to durability analysis (fatigue

life prediction) and dependable techniques for dealing with variances inherent in engineering construction during the last ten years. The factors of the wheel rim, including its size, weight, design, and materials, have an influence on the braking performance. The size of the wheel rim determines how much space is left between the brake rotor and the wheel rim. There will be more room for air flow around the air flow if the wheel rim's diameter is increased, which will improve cooling. The weight of the wheel rim is yet another consideration that must be made. Lighter vehicles almost usually have better handling because of their reduced weight. The rotational inertia is also an evident aspect that goes higher with increasing weights, which causes the brakes to have to do much more work. Wheel flex and strength are two additional aspects of handling that need to be considered. Wheel flex may be reduced by making the wheel more stiff. This is of the utmost importance since large cornering forces may be generated by high performing performance even with a low aspect ratio. Steel wheels and alloy wheels are the two primary categories that make up the larger category of car wheels. Wheels made of alloy are regularly installed on contemporary automobiles, particularly when the vehicle is designed for turning. The wheel disc and the rim are both pressed components that are used in the construction of every steel wheel. These components are then welded together.[4-8]

IMPLEMENTATION[9,10]

- Kia Carnival Prestige: kerb weight of 4839 pounds, or 2195 kilogrammes
- Calculate the net mass of the Kia Carnival Prestige by subtracting the mass of the tyre rim from the mass of the vehicle. Assume that the mass of the wheel rim is 19,06 pounds or 65 kilogrammes.
- If we assume that the mass of the Kia Carnival Prestige without the wheel rim is 2160 kilogrammes, then the mass of the vehicle is 2160.4 kilogrammes.
- Let us suppose that every individual has their maximum possible quantity of mass (105kgs).If the total body weight is 2475kg and there are 3 members, then the total body weight is 2160kg plus 315kg, which is 2475kg.
- If the combined weight of all five members is 525 kilogrammes, then the total body mass is 2685 kilogrammes and 26330 Newtons.
- If 7 people add up to 735 kilogrammes, then the total body weight is 2895 kilogrammes, which is 28390 Newtons.
- If the sum of the weights of all nine members is 945 kilogrammes, then the total body mass is 3105 kilogrammes and 30450 Newtons. The formula for angular velocity is as follows: $= V/r$ $V = 150 \text{ km/h} = 41.66 \text{ m/s}$ $r = 0.229 = 181.92 \text{ rad/s}$ as seen in Table 1.

Table 1: Wheel rim specifications.

Kia carnival prestige	
Kia carnival prestige Rim main diameter	458mm
Kia carnival prestige Rim width	178mm
Kia carnival prestige Rim shaft diameter	35mm
Kia carnival prestige stud diameter	12mm
Kia carnival prestige Thickness of wheel rim	6mm
Kia carnival prestige Number of studs	4

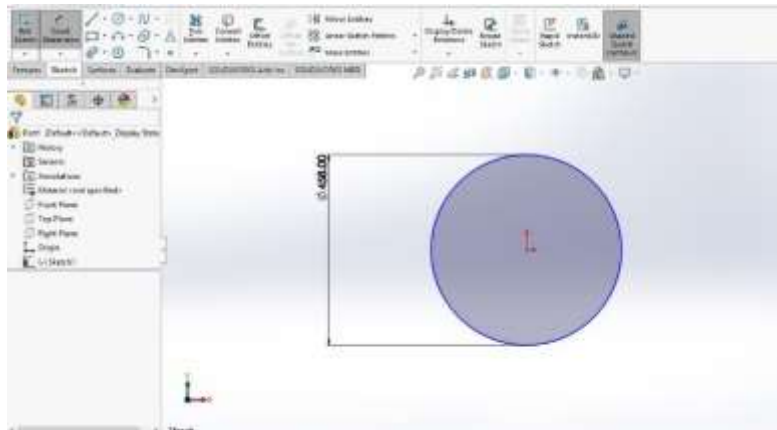


Fig. 1: Rim main diameter value.

Above Figure 1 represents the Kia carnival prestige Rim main diameter value, and here outer diameter values mentioned as 458mm

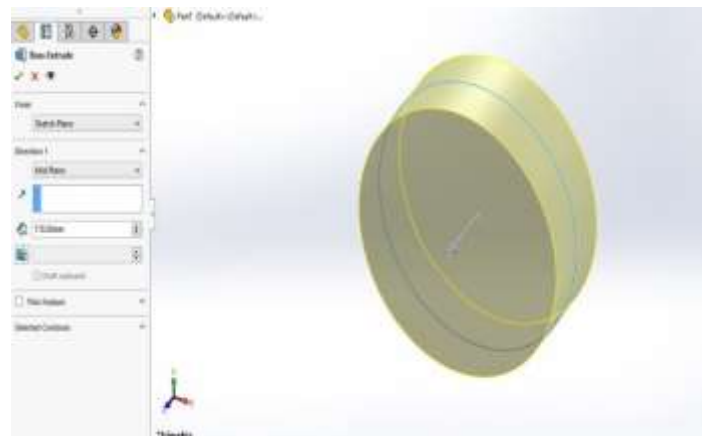


Fig. 2: Rim 3D conversion.

After completing diameter of Kia carnival prestige Rim, now exit and then select, extrude option to convert into 3D object, and enter length of the object as 178mm as shown in Figure in Figure 2 and 3.

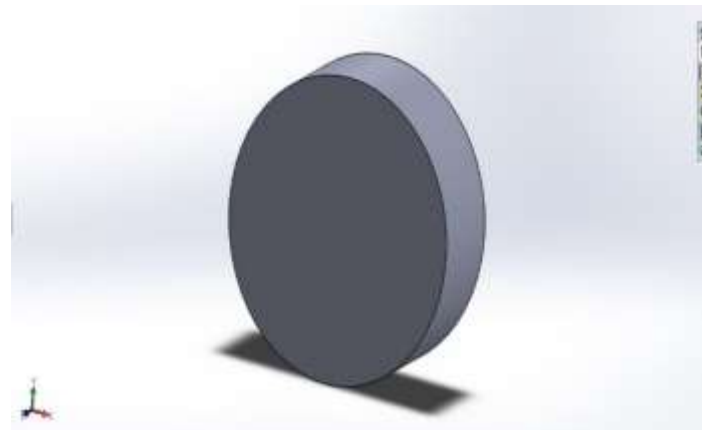


Fig. 3: Rim 3D conversion.



Fig. 4: Final Rim 3D conversion.

To create outer surface of the wheel rim, here used revolve cut option, and the final image shown in above Figure 4, 5 and 6.

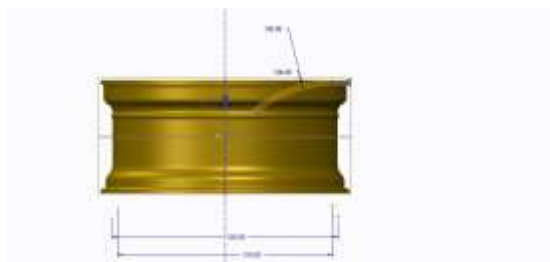


Fig. 5: Final Rim 3D Side View.



Fig. 6: Final Rim 3D Conversion.

RESULTS

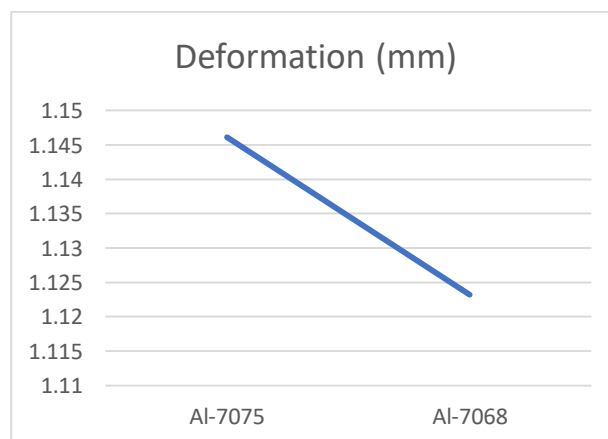


Fig. 7: Deformation Comparison Result of 3 Member load.

The above Figure 7 represents the deformation values of the Kia carnival prestige wheel rim and when it undergoes three-member load boundary conditions al-

7075 material is having high deformation values and al-7068 material is having fewer deformation values.

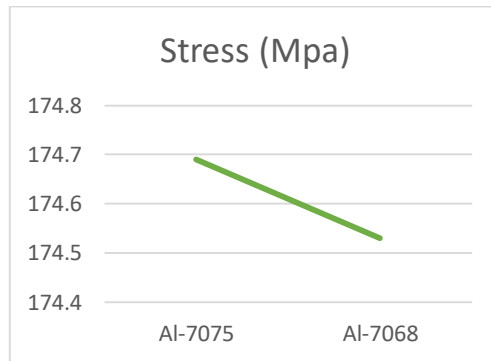


Fig. 8: Stress Comparison Result of 3 Member load.

Above Figure 8 represent the stress values of the Kia carnival prestige wheel rim and when it undergoes three-member load

boundary conditions al-7075 material is having high stress values and al-7068 material is having less stress values.

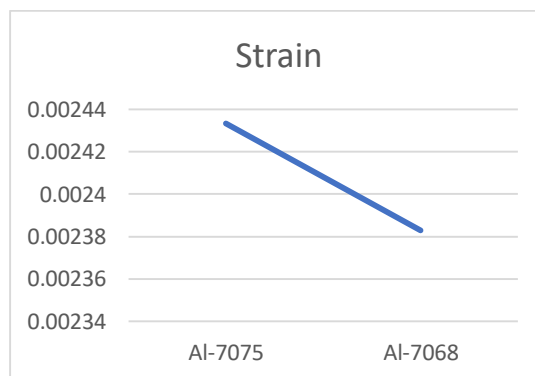


Fig. 9: Strain Comparison Result of 3 Member Load.

Above Figure 9 represent the strain values of Kia carnival prestige wheel rim and when it undergoes three-member load

boundary conditions al-7075 material is having high strain values and al-7068 material is having fewer strain values.

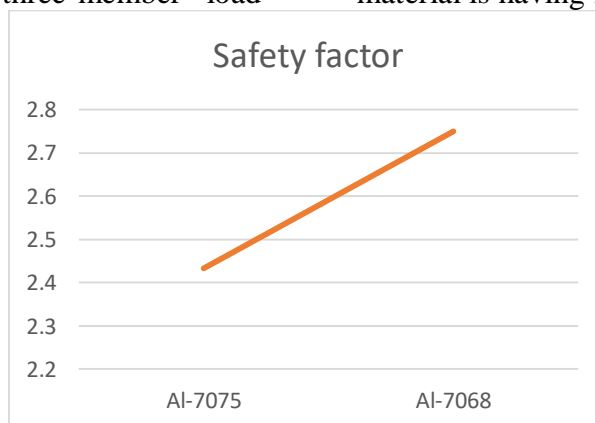


Fig. 10: Safety Factor Comparison Result of 3 Member Load.

Above Figure 10 represent the safety factor values of Kia carnival prestige wheel rim and when is undergoes three-member load boundary conditions al-7068

material is having high safety factor values and al-7075 material is having less safety factor values.

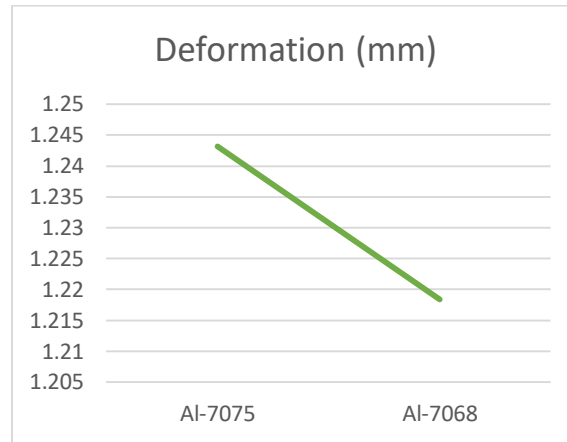


Fig. 11: Deformation Comparison Result of 5 Member Load.

Above Figure 11 represent the deformation values of Kia carnival prestige wheel rim and when is undergoes five-member load boundary conditions al-7075 material is

having high deformation values and al-7068 material is having less deformation values.

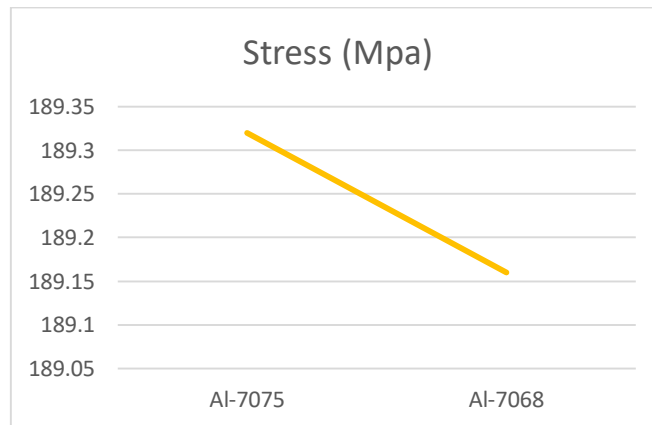


Fig. 12: Stress Comparison Result of 5 Member Load.

Above Figure 12 represent the stress values of Kia carnival prestige wheel rim and when is undergoes five member load

boundary conditions al-7075 material is having high stress values and al-7068 material is having less stress values.

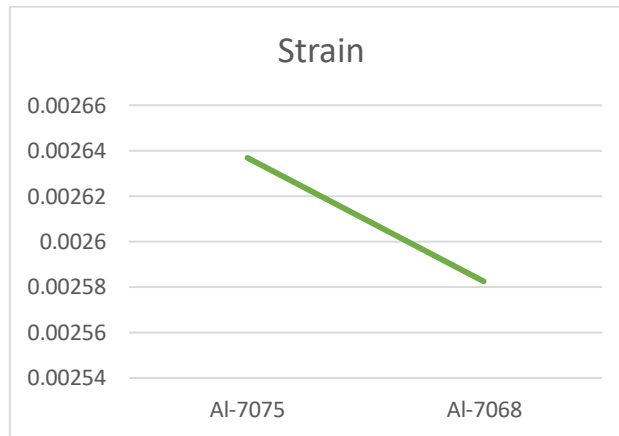


Fig. 13: Strain Comparison Result of 5 Member Load.

Above Figure 13 represent the strain values of Kia carnival prestige wheel rim and when is undergoes five-member load

boundary conditions al-7075 material is having high strain values and al-7068 material is having less strain values.

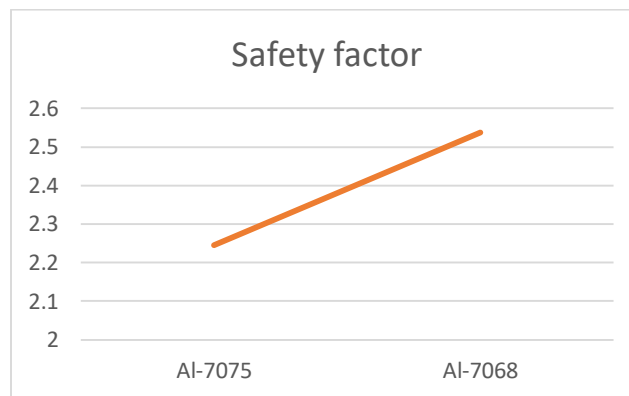


Fig. 14: Safety Factor Comparison Result of 5 Member Load.

The above Figure 14 represent the safety factor values of the Kia carnival prestige wheel rim and when is undergoes five-member load boundary conditions al-7068 material are having high safety factor

values and al-7075 material is having less safety factor values. The Structural analysis results for 3 & 5 Member Load is shown in Table 2 and 3 below.

Table 2: Structural analysis results for 5 Member Load.

3 members	Al-7075	Al-7068
Deformation (mm)	1.1461	1.1232
Stress (Mpa)	174.69	174.53
Strain	0.0024333	0.0023828
Safety factor	2.4328	2.7503

Table 3: Structural analysis results for 3 Member Load.

5 members	Al-7075	Al-7068
Deformation (mm)	1.2432	1.2184
Stress (Mpa)	189.32	189.16
Strain	0.002637	0.0025825
Safety factor	2.2449	2.5376

CONCLUSION

In this paper, Kia carnival prestige vehicle wheel rim modelling and analyzing with CAD/CAE tools, here object is developed with the help of solid works and then analyzing with structural and dynamic boundary conditions, and also suggests a material which withstands high-speed maximum load boundary conditions. Here al-7075 and al-7068 materials were chosen to analyze, here Kia carnival prestige vehicle is chosen and analysed with minimum load to maximum load boundary conditions *i.e.*, 3 to 5 members' loads. Finally, paper concludes optimum material.

From analysis results here observed that al-7068 material is suitable in both conditions like structural and dynamic, and it has high strength to weight ratio values, and also less in weight compare to al-7075 material. also al-7068 material has high safety factor values with the least stress values, and this can increase the vehicle performance in terms of less fuel consumption due to less in weight. And also increase the durability of the object, finally paper concludes with al-7068 material.

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