ISSN: 2321-2152

IJMECE

International Journal of modern electronics and communication engineering

E-Mail
editor.ijmece@gmail.com
editor@ijmece.com

www.ijmece.com

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

MODELLING AND ANALYSIS OF CAR WHEEL RIM USING CAD/CAE TOOLS

[1] K.Akhil Chawan, [2] V.Vinay, [3] K.Vinay, [4] P.Amar, [5]Mr.T.Gurumurthy,
[1234] Student Department of Mechanical Engineering, SRI INDU COLLEGE OF ENGINEERING & TECHNOLOGY, Ibrahimpatnam, Hyderabad.
[5]Assistent Professor,Department of Mechanical Engineering, SRI INDU COLLEGE OF ENGINEERING & TECHNOLOGY, Ibrahimpatnam, Hyderabad.

Abstract

Therimisthe "outer edge ofa wheel, holdingthe tire". It makes up the outer circular designofthe wheelon which the inside edge of the tireis mounted on vehicles such as automobiles.In this work Kia carnival prestige vehicle wheel rim modelling and analyzingwithCAD/CAE tools,hereobjectdeveloped withthe helpofsolid worksandthenanalyzed withstructuralanddynamic boundary conditions, and also the best material is suggested can withstand high speed maximum load boundary conditions. Here, Al-7075 and Al-7068 materials were chosen to analyze the properties.

Kiacarnivalprestigevehiclewaschosenandanalyzed with minimumloadto maximumloadboundaryconditionsi.e.,for 3, 5 and 7 members load.

From result analysis it is observed that Al-7068 material is suitable for both conditions like structural and dynamic, and ithas strength to weight ratio values, and also less in weight compare to Al-7075 material. This Al-7068 has very good natural frequency range values, and which withstand more vibrations than Al-7075, and also Al-7068 material has high safety factor values with least stress values, and this can increase the vehicle performance in terms of less fuel consumption due to less inweight and increase the durability of the object. Finally, it is concluded that Al-7068 material is best when compared to Al-7075 material.

Introduction

Wheelrim

Therimisthe"outeredgeofa wheel, holdingthetire". It makes upthe outercirculardesignofthe wheelon whichthe insideedge of thetireis mounted on vehicles such as automobiles. Forexample, on a bicyclewheel the rim is a largehoop attached to the outer ends of the spokes of the wheel that holds the tire and tube. In cross-section, the rim is deep in the center and shallow at the outer edges,

2.0LITERATUREREVIEW

- Kisshan, JL Miren, et al. "arranged and performed static and Eigenvalue Buckling examination on fabricated steel wheel rim and aluminum wheel rim. In both examination of made steel wheel edge and aluminum wheel edge, von-mises stresses are lessdiverged fromoutrageous strength. Redirections got more inaluminumedge thandelivered steel edge. They wrapped up andleanedtowardthatdeliveredsteeledgegavebetterresultswhenappeareddifferentlyinrelationtoaluminumwheel edge.
- Ashok Kumar, G., et al. arranged a composite wheel in CATIA and performed examination by using ANSYS programming on wheel edge of TATA Indica. The static fundamental examination was proceeded with composite wheel by applying the three unmistakable materials specifically aluminum (AL 6061), zinc (ZA 21) and Magnesium (Mg). They saw similar weights and complete turning of compound wheels, and construed that most noteworthy outright misshapening and indistinguishable nerves are procured least for ZA 21 stood out from aluminum and magnesium.

DesignConsiderationsandCalculationscarwheel rim

CurbweightKiacarnivalprestige=4839lbs.→2195Kgs

MassofKiacarnivalprestige withoutwheelrim=netmass –(massofwheelrim*4) Let

mass of wheel rim is 19.06bs → 8.65 Kg s

MassofKiacarnivalprestige without wheelrim(m)=2195-34.6Kgs=2160.4Kgsandassumeit2160Kgs Let us assume

each person has maximum amount of mass (105 kg s).

For3members=315kgs→thentotalbody=(2160+315kgs)=2475kgs →24271N For 5

members = 525kgs→ then total body= (2160+525kgs) = 2685kgs→26330N

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

For7members=735kgs→thentotalbody=(2160+735kgs)=2895kgs→28390N

AngularVelocity:

ω=V/r

V=150km/hrs.=41.66m/s r

= 0.229

ω=181.92rad/s

Wheelrimspecifications

Wheelrimisdesigningbyusingthesebellowspecifications Table

3.1 Wheel rim specifications

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

4.0 SOLIDWORKSDESIGNINGPROCESS

Designingthe wheelrimbyusingsolid works2018 SP05 software version,openthesoftwareand selectpart,then anewpage is displayed. In that page design is developed by using the features, Sketch, Surfaces, Evaluate, Exit Sketch, Smart Dimension, Trim Entities, Offset Entities and Instant2D by using this option we build the wheel rim.

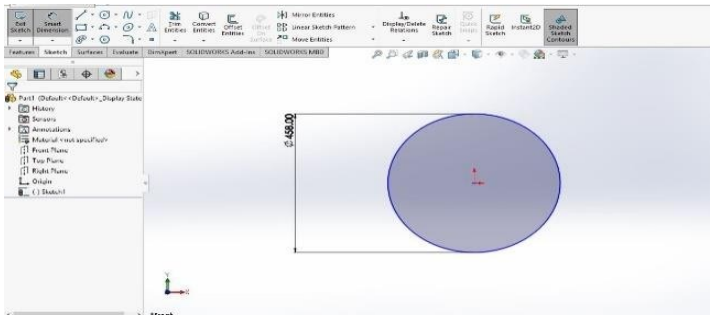

Fig:4.1RimDrawninSolidworkswithdiameter458mm.

AboveimagerepresentstheKiacarnivalprestigeRimmaindiametervalue,andhereouterdiametervaluesmentionedas458mm.

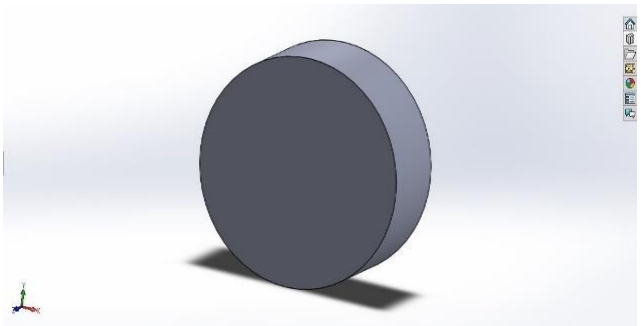

Fig:4.23DModelof Rim

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

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.

Fig:4.3Wheelrimfinalmodel

Tocreateoutersurfaceofthewheelrim,hereusedrevolvecutoption,andthefinalimageshowninabove.

5.0 STRUCTURALANALYSISRESULTS

Materialproperties

Al-7075	Young'smodulus	71.7E^9 Pa
	Poisonratio	0.33
	Density	2810 Kg/m^3
	Yieldstrength	503 Mpa
Al-7068	Young'smodulus	73.25E^9Pa
	Poisonratio	0.315
	Density	2770 Kg/m^3
	Yieldstrength	580 Mpa

Membersboundaryloadconditions

Above wheel rimisconverted into small particles with the help ofelementsand nodes, and this entire process knownas meshing, and this meshing helpful to solve the results of finite element analysis. Here elements and nodes quantity will change while increasing or decreasing the element size, if the element size is small then the elements and nodes quantity will be high, and if the element size is high and the elements and nodes, quantity will be low. When the element size is verysmall then the results will be more accurate to real time applications, and in this thesis, element size is used 1mm only. In addition, this meshing called as fine mesh.

After completing meshing process now select boundary conditions, and here boundary conditions were chosen as human weight andluggage weight,andalsorotationalvelocityofthe vehicle,hereassumed vehicleistravellingataspeedof150kmp/h, andthen converted it to rotational velocityand the value is 181.92 rad/s, and the value is 3members load is 24271N. In addition, the object fixed at studs' position. All these boundary conditions applied areas and their values are shown in below image.

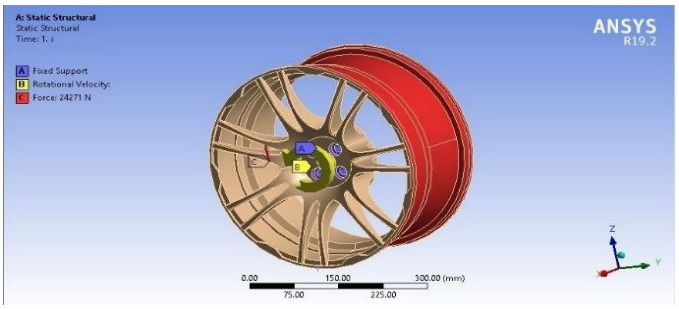

Fig:5.1Boundaryconditionfor3membersload.

Letusassumeeachpersonhasmaximumamountofmass(105kgs).

Selectfixedsupportatstuds,andthenselectrotationalvelocityandentervalueas181.92rad/sec For 3 members = →24271N apply and then solve

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

3MembersboundaryloadconditionDeformationResultsforAl-7075

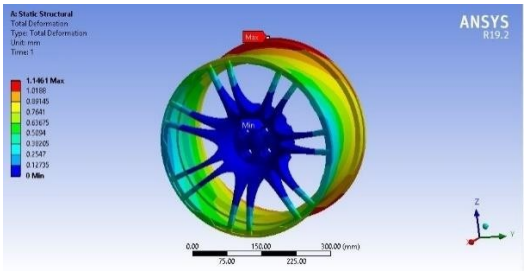

Fig:5.23MembersboundaryloadconditionDeformationResultsforAl-7075

3MembersboundaryloadconditionsStressResultsforAl-7075

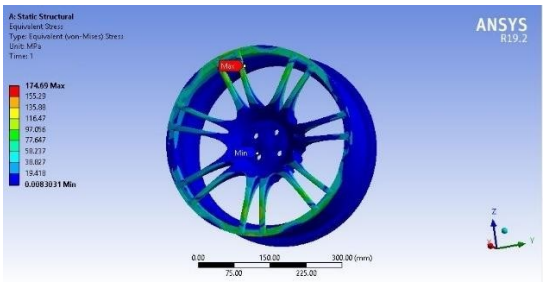

Fig:5.33MembersboundaryloadconditionStressResultsforAl-7075

3MembersboundaryloadconditionStrainResultsforAl-7075

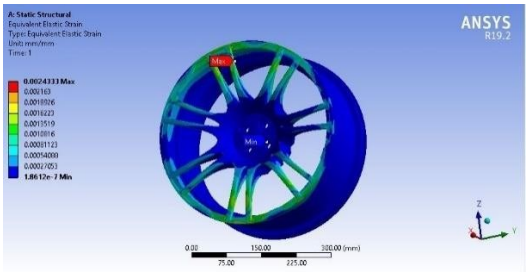

Fig:5.43MembersboundaryloadconditionStrainResultsforAl-7075

MembersboundaryloadconditionsSafetyfactorResultsforAl-7075

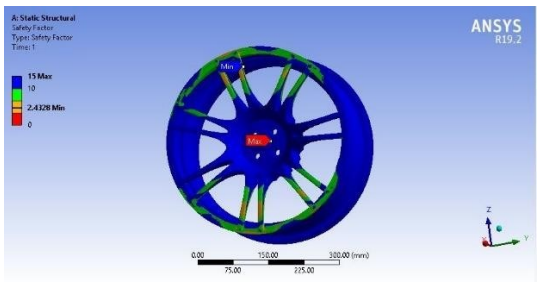

Fig:5.53MembersboundaryloadconditionSafetyfactorResultsforAl-7075

STRUCTURALANALYSISRESULT'STABLES

Applying the 3, 5 and 7 members load on wheel rim and taken results at the boundary conditions i.e. Deformation, stress,strain and safety factor

3Membersboundaryloadcondition

Thefollowingtableshowsdeformation,stress,strain,safetyfactorfor3membersboundaryloadconditioniscomparedtoAl- 7075 & Al-7068 materials.

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

Table5.13Membersboundaryloadcondition

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

5Membersboundaryloadcondition

Thefollowingtableshowsdeformation,stress,strain,safetyfactorfor5membersboundaryloadconditioniscomparedtoAl- 7075 & Al-7068 materials.

Table5.25Membersboundaryloadcondition

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

7Membersboundaryloadcondition

Thefollowingtableshowsdeformation,stress,strain,safetyfactorfor3membersboundaryloadconditioniscomparedtoAl- 7075 & Al-7068 materials.

Table5.37Membersboundaryloadcondition

7members	Al-7075	Al-7068
Deformation (mm)	1.3403	1.3135
Stress(Mpa)	203.96	203.81
Strain	0.0028409	0.0027825
Safetyfactor	2.0838	2.3552

- In 3 members boundary load condition Al-7075 material is Deformation is 1.1461 mm, Stress is 174.69 Mpa, Strain is 0.002433, Safety factor is 2.4328 and for Al-7068 material is Deformation is 1.1232 mm, Stress is 174.53 Mpa, Strain is 0.0023828, Safety factor is 2.7503.
- In 5 members boundary load condition Al-7075 material is Deformation is 1.2432 mm, Stress is 189.32 Mpa, Strain is 0.002637, Safety factor is 2.2449 and for Al-7068 material is Deformation is 1.2184 mm, Stress is 189.16 Mpa, Strain is 0.0025825, Safety factor is 2.5376.
- In 7 members boundary load condition Al-7075 material is Deformation is 1.3403 mm, Stress is 203.96 Mpa, Strain is 0.0028409, Safety factor is 2.0838 and for Al-7068 material is Deformation is 1.3135 mm, Stress is 203.81 Mpa, Strain is 0.0027825, Safety factor is 2.3552.

It is observed that the Deformation, Stress and Strain values are less for Al-7068 when compared to Al-7075 material with high in Safety factor

6.0 DYNAMICANALYSISRESULTS

Boundaryconditions

In dynamic analysis, natural frequency results calculated with the help of self-weight of the object. A sound wave is created as a result of a vibrating object. The vibrating object is the source of the disturbance that moves through the medium

Thenaturalfrequencyisimportantformanyreasons:

1 Allthingsintheuniversehaveanaturalfrequency,andmanythingshavemorethanone

ISSN 2321-2152
www.ijmece.com
Vol 13, Issue 2, 2025

2 Anobject'snaturalfrequency,youknowhowitwillvibrate.

3 Anobjectvibrates,youknowwhatkindsofwavesitwillcreate.

4 Inspecifickindsofwaves,youneedtocreateobjectswithnaturalfrequenciesthatmatchthewavesyouwant.

Degreesoffreedom

Anobjectisspacehassixdegreesoffreedom.Inthosethreedegreesaretranslationandanotherthreearerotation.

- Translation–movementalongX,YandZ-axis.
- Rotation–rotateaboutX,YandZ-axis.

Herewheel studs fixedat center and then selectedmodes 6and then solving eachmode naturalfrequency value results and the results shown in below. The tests are conducted at 6 modes i.e.

Mode1------ TranslationonX-axis

Mode2------ TranslationonY-axis

Mode3------ TranslationonZ-axis

Mode4------ RotationonX-axis

Mode5------ RotationonY-axis

Mode6------ RotationonZ axis

Wheelstudsfixedatcenterplainaxis

Fig:6.1Wheelstudsfixedatcenterplainaxis

6.3TableNaturalfrequencyvalueonsixdegreesoffreedom

ThefollowingtableshowstheNaturalfrequencyAl-7075andAl-7068materialsobtainvalue.
Table6.1Naturalfrequencyvalueonsixdegreesoffreedom

	Al-7075	**Al-7068**
Mode1(hz)	294.96	304.21
Mode2(hz)	341.38	352.06
Mode3(hz)	342.15	352.88
Mode4(hz)	349.65	360.01
Mode5(hz)	353.29	363.59
Mode6(hz)	485.01	499.84

7.0 CONCLUSION

In this work Kia carnival prestige vehicle wheel was developed with the help of solid works and then analyzed with structural and dynamic boundary conditions, and also suggested the best a material which can withstand high speed maximum boundary load conditions.Al-7075 and Al-7068 materials were chosen as materials for analysis.

Kiacarnivalprestigevehicle chosenand analyzed withminimumload to maximumboundaryload conditionsi.e.,3to5 and7 members' loads.

- In 3 members boundary load condition Al-7075 material is Deformation is 1.1461 mm, Stress is 174.69 Mpa, Strain is 0.002433, Safety factor is 2.4328 and for Al-7068 material is Deformation is 1.1232 mm, Stress is 174.53 Mpa, Strain is 0.0023828, Safety factor is 2.7503.

- In 5 members boundary load condition Al-7075 material is Deformation is 1.2432 mm, Stress is 189.32 Mpa, Strain is 0.002637, Safety factor is 2.2449 and for Al-7068 material is Deformation is 1.2184 mm, Stress is 189.16 Mpa, Strain is 0.0025825, Safety factor is 2.5376.
- In 7 members boundary load condition Al-7075 material is Deformation is 1.3403 mm, Stress is 203.96 Mpa, Strain is 0.0028409, Safety factor is 2.0838 and for Al-7068 material is Deformation is 1.3135 mm, Stress is 203.81 Mpa, Strain is 0.0027825, Safety factor is 2.3552.
- InMode1i.e.TranslationonXaxis,TheNaturalfrequencyisobservedforAl-7075is294.96andAl7068is304.21.
- InMode2i.e.TranslationonYaxis,TheNaturalfrequencyisobservedforAl-7075is341.38andAl7068is352.06.
- InMode3i.e.TranslationonZaxis,TheNaturalfrequencyisobservedforAl-7075is342.15andAl7068is352.88.
- InMode4i.e.RotationonXaxis,TheNaturalfrequencyisobservedfor Al-7075 is 349.65 and Al 7068 is 360.01.
- InMode5i.e.RotationonYaxis,TheNaturalfrequencyisobservedfor Al-7075 is 353.29 and Al 7068 is 363.59.
- InMode6i.e.RotationonZaxis,TheNaturalfrequencyisobservedforAl-7075is485.01andAl7068is499.84

Fromresultanalysisit isobserved thatAl-7068 materialissuitablefor bothconditionslikestructuraland dynamic, and ithas strength to weight ratio values, and also less in weight compare to Al-7075 material. This Al-7068 has very good naturalfrequency range values, and which withstand more vibrations than Al-7075, and also Al-7068 material has high safety factor values with least stress values, and this can increase the vehicle performance in terms of less fuel consumption due to lessin weight and also increase the durability of the object. Finally it is concluded that Al-7068 material is best when compared to Al- 7075 material.

References

[1]. Sasank Shekhar Panda, Jagdeep Gurung, Udit KumarChatterjee, Saichandan Sahoo, “Modeling-And-Fatigue Analysis-Of-Automotive-Wheel-Rim’’, International Journal Of Engineering Sciences & Research Technology, 5(4): April, 2016.

[2].SachinS.Mangire,Prof.SayedL.K,Prof.SayyadL.B,“StaticAndFatigueAnalysisOfAutomotiveWheelRim’’, International Research Journal of Engineering and Technology, Volume: 02 Issue: 05, Aug-2015.

[3].H.N.Kale,Dr.C.L.Dhamejani,Prof.D.S.Galhe,“ComparativeStudyofWheelRimMaterials’’,Vol-1Issue-52015 IJARIIE.

[4]. Mr. Sushant K. Bawne, Prof. Y. L. Yenarkar, “OptimizationOf Car Rim”, Mr. Sushant K. Bawne Int. Journal ofEngineering Research and Applications, Vol. 5, Issue 10, (Part - 2) October 2015, pp.01-08.

[5]. Turaka.venkateswara Rao, Kandula. Deepthi, K.N.D. Maleswena Rao, “Design & Optimization of a Rim Using FiniteElement Analysis’’, Vol. 04 , Issue, 10, October – 2014, International Journal of Computational Engineering Research (IJCER).

[6]. V.Karthi, N. Ramanan, J. Justin Maria Hillary, “Design and Analysis of Alloy Wheel Rim’’, International Journal of Innovative Research in Science, Engineering and Technology, Volume 3, Special Issue 2, April 2014.

[7]. S. Ganesh, Dr. P. Periyasamy, “Design and Analysis of Spiral Wheel Rim for Four Wheeler’’, The International Journal Of Engineering And Science (IJES), Volume 3, Issue 4, Pages 29-37 , 2014 .

[8]. P. Meghashyam, S. Girivardhan Naidu and N. Sayed Baba, “Design and Analysis of Wheel Rim using CATIA & ANSYS’’, Volume 2, Issue 8, August 2013, International Journal of Application or Innovation in Engineering & Management(IJAIEM).

[9]. H. N. Kale, Dr. C. L. Dhamejani, Prof. D. S. Galhe, “A Review on Materials Used For Wheel Rims’’, Vol-1 Issue-5 2015 IJARIIE.

[10].V.Dharanikumar,S.Mahalingam,A.Santhoshkumar,“ReviewonFatigueAnalysisofAluminumAlloyWheelunder Radial Load for Passenger Car’’, 2014 IJEDR Volume 3, Issue 1.

[11]. S Vikranth Deepak, C Naris and Syed Altaf Hussain, “Modelling an Analysis of Alloy Wheel for Four-Wheeler Vehicle’’,Int. J. Mech. Eng. & Rob. Res. 2012.

[12].RajarethinamP.,PeriasamyK.,“ModificationofDesignandAnalysisofMotorCycleWheelSpokes’’,International Conference on Advances in Engineering and Management (ICAEM).