Design and Structural Analysis of Steering Knuckle for An Electric All-Terrain Vehicle - E Baja

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***Abstract*:- Steering knuckle is a component which is used as a connection between the wheels , suspension and braking system and also helps the wheels of the vehicle to turned in the required direction. The reason for this research paper is to design a knuckle which has low weight so that vehicle unsprung mass can be reduced. Design is an important factor in product development cycle.By the decrease of the unsprung mass of the vehicle the riding characteristics of the vehicle can be improved.The strength and durability of the component is maintained by the usage of the ligt weight aluminium T6 7075 rather than the grey cast iron and mild steel. This study involve two steps.First step is to design the component and second step is to do the finite element analysis to find the stresses induced and to know the deformation of the component. The design is done with the help of the Catia V5 and the analysis is done with the help of Ansys work bench 15.0.**

Key Words : Steering knuckle, All terain vehicle, FEA, Bump ,Cornering, Braking, Al-7075-T6

INTRODUCTION

Steering knuckle is one of the important component in the vehicle which is used to provide the front wheels to turn in the requried direction. Knuckle converts the linear motion of the tie rod to angular motion of the stub axle.Knuckle is used to join the components like brake caliper , tie rods ,upper and lower ball joints.Knuckle design can be done into two types based up on the type suspension we are using either the mach-person struct or the double wish bone suspension. A steering knuckle is designed in a such a way that it can be capable to with stand the forces and torqes acting on it due to bumps ,braking,acceleration,and steering action.To obtain the good riding chracteristics of a vehicle the unsprung mass of the vehicle should to be reduced.Nearly 90 % of the unsprung mass contains the wheel assembly. So our goal is to design a knuckle which has a weight as low as possible.For the design of knuckle we have to maily consider parameters like king pin inclination, caster angle and the distance between the upper and lower ball joints.As atv vehicle runs on the bumpy roads good factor of safety is required for the knuckle component to withstand those conditions

RESEARCH PROCEDURE

1 . Study of knuckle to know the different parameters affecting it

2 . Slection of material

3 . Designing the components

4 . Meshing the model

5 . Applying the various loads acting on the component

6 . Stress analysis

7 . Optimization

8 . Results

PROPERTIES OF GREY CAST IRON,MILD STEEL AND

ALUMINIUM 7075 T6

1.MILD STEEL

PYSICAL PROPERTIES		
QUANTITY	**VALUE**	**UNIT**
Density	7.87	g/cm^3
MECHANICAL PROPERTIES		
QUANTITY	**VALUE**	**UNIT**
Tensile strength, Ultimate	370	Mpa
Tensile strength,yield	370	Mpa
Youngs modulus	205	Gpa
Poisson ratio	0.290	-

2. Cast Iron

PHYSICAL PROPERTIES		
QUQNTITY	**VALUE**	**UNIT**
Density	7.87	g/cm^3
MECHANICAL PROPERTIES		
QUQNTITY	**VALUE**	**UNIT**
Tensile strength, Ultimate	520-570	Mpa
Tensile strength,yield	540	Mpa
Youngs modulus	200	Gpa
Poisson ratio	0.291	-

3.ALUMINIUM 7075 T6

ELEMENT	Cu	Mn	Si	Cr	Mg	Ti	Zn	Al
% WEIHT	1.2-2	Max 0.3	0.4 Max	0.18-0.28	2.1-2.9	0.2 MAX	5.1-6.1	87.1-914

PHYSICAL PROPERTIES

Properties	VALUE	UNIT
Density	2.81	g/cm^3
Tensile strength, Ultimate	115	Mpa
Hardness (HB500)	30	60
Elastic modulus	70-80	Gpa
Poisson ratio	0.33	-

Load calculations:

Total weight of the vehicle : 380kg

Weight on front portion of the vehicle=50%=190kg.

Weight on the rear portion of the vehicle=50%=190kg.

Weight on the one wheel=(190/2)=95kg.

Loading types:

Bump condition =3G=(3*9.81*95)=2795.85N.

Cornering condition=3G=(3*9.81*95)=2795.85N.

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Breaking force=1.5G=(1.5*9.81*95)=1397.92

Force acting on each brake mount=(1397.92/2)=698.96N

Distance from knuckle centre to brake mount=95mm

Moment acting on each mount=(brake force per mount *perpendicular distance)

=(698.96*95)=66401.43N-mm

Moment acting on upper brake mounting point=66401.43N-mm

Moment acting on lower brake mounting point=66401.43N-mm

LOADING CONDITIONS

In the design of the knuckle the upper and lower 'A' arm mounting points and the steering arm are fixed .Bump load is given along the 'Y' axis, cornering force is given along the 'Z' axis and the braking force is applied on 'X' axis on the brake mounting points

M0DELLING

In this research paper the model is prepared using the catia v5 software . After designing the model the file is saved in IGS format and then it is imported to ansys for analysis the model by applying the various loads . By the help of the ansys software the structial analysis is done and results were obtained differently for the three different materials . Then by comparing the results obtained for different materials , the materials which has low weight and good factor of safety is selected and with this material the knuckle model is manufacture

MESH MODEL

The errors in the geometry is corrected and the model is meshed . The type of mesh selected is fine mesh

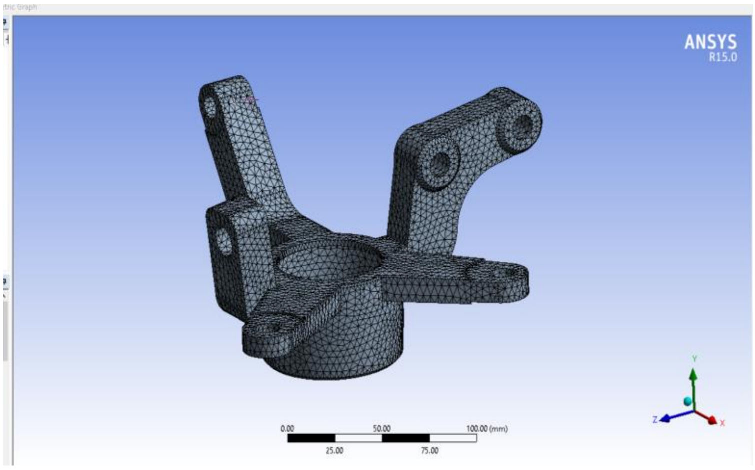

fig:1 mesh model of the knuckle

1) ALUMINIUM T6 7075

The following figures shows the stress destribution and the total deformation of the AL T6 7075 material

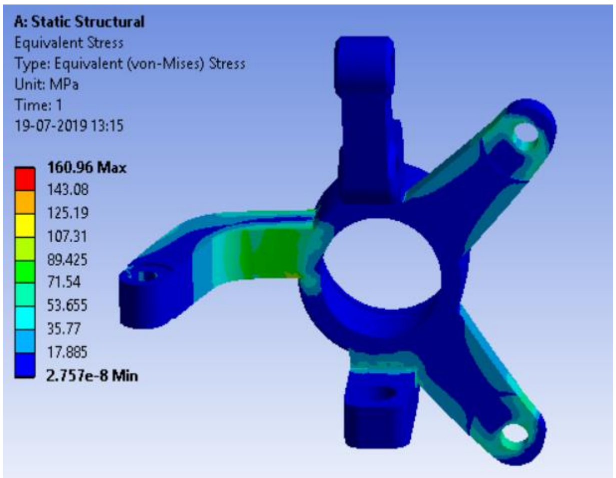

fig :2 Equivalent stess distribution

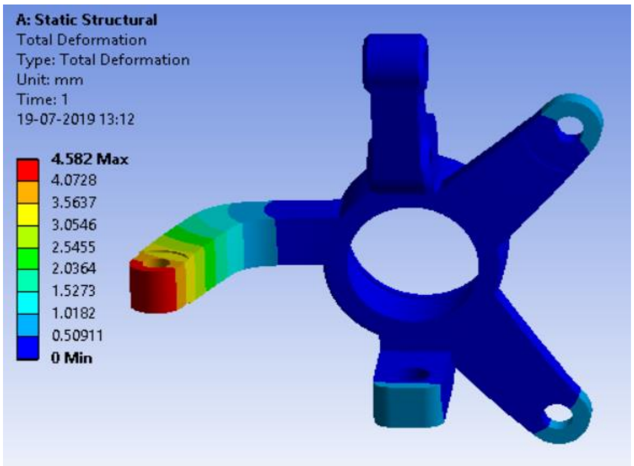

fig:3 Total deformation

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1 Maximum stress distribution :160.96 Mpa

2 Maximum total deformation :4.582 mm

3 Total ultimate tensile strength :572 Mpa

2 Mild steel

The following figures shows the stress destribution and the total deformation of the mild steel material

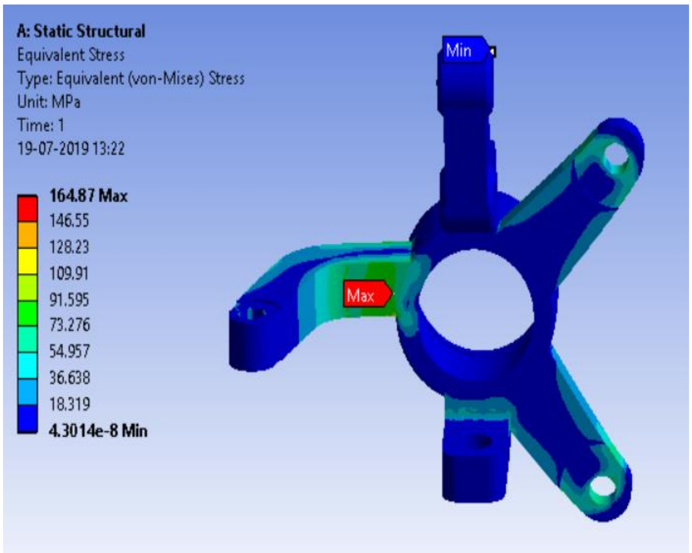

fig:4 Equivalent stess distribution

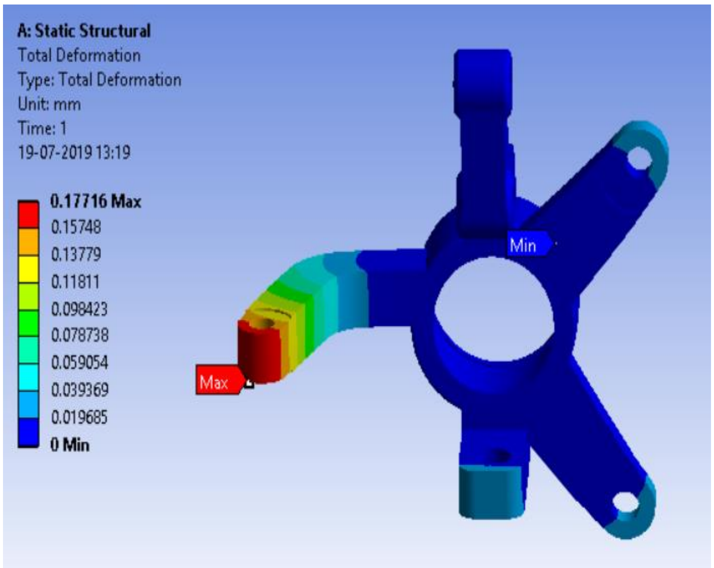

fig:5 Total deformation

1 Maximum stress distribution :164.87 Mpa

2 Maximum total deformation :0.17716 mm

3 Total ultimate tensile strength :460 Mpa

3 Cast iron

The following figures shows the stress destribution and the total deformation of the cast iron material

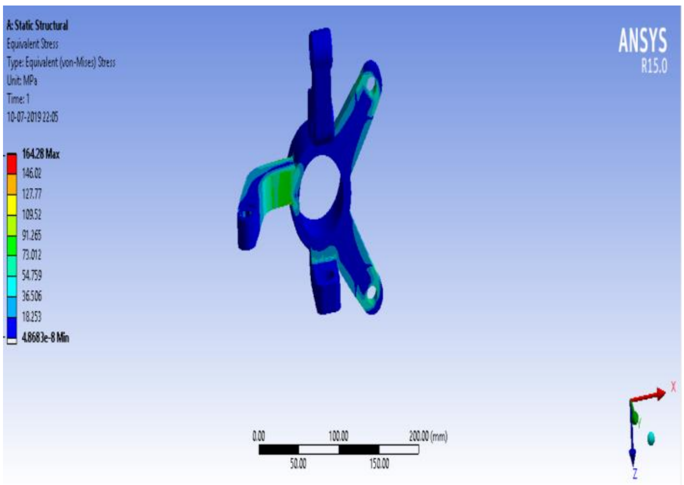

fig:6 Equivalent stess distribution

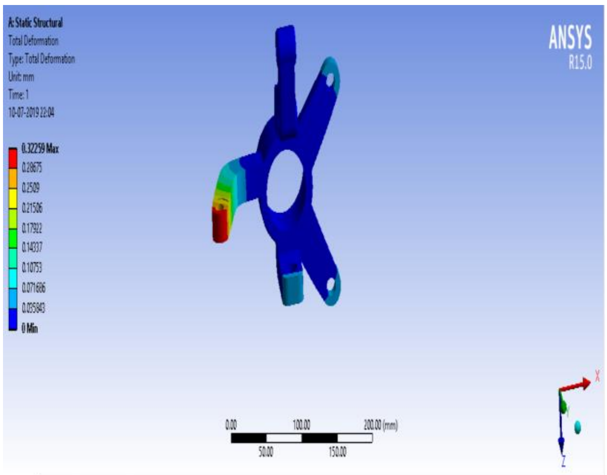

fig:7 Total deformation

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1 Maximum stress distribution :164.28 Mpa

2 Maximum total deformation :0.32259 mm

3 Total ultimate tensile strength : 240 Mpa

RESULT

The factor of safety of all the three materials are calulated

Factor of safety = ultimate tensile strength /working stresses

1 . For aluminium T6 7075 = 572/160.96 =3.5

2 . For mild steel = 460/164.87 =2.7

3 . For cast iron = 240/164.28 =1.4

CONCLUSION

From the above analysis report when compared to all three materials aluminium T6 7075 material has the higher factor of safety . when compared to the weight al T6 7075 material has low weight than cast iron and mild steel . So we prefer to the aluminium T6 material for the manufacturing of the steering knuckle

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