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Design and Analysis BAJA ATV's Half Axle

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***Abstract*: This design report explaining Engineering design process and analysis of Half Axle which has been developed for the BAJA ATV. The society of Automotive Engineers (SAE) BAJA Senior design project enables student to gain real world experience in the design, Analysis and Manufacture the vehicular product. Finite Element Analysis has been conducted on the Half Axle to ensure the safety. This report is details of procedure and methodology used for the Design Of Axle. The conventional half shaft is usually over designed so team makes the custom shaft to reduce the mass and rotational inertia. The main criteria considered in the design included High performance, reliability, Manufacturability, serviceability, weight and cost.**

Keywords: Half Axle, Computer-aided Engineering (CAE), Analysis, Differential Gear Box.

1. INTRODUCTION

The Half Axle is device which is transfer the power means of rotational motion from differential gear box to the wheel [1]. The one end is engaged with the differential gear box while another to the wheel hub assembly. THE SUSPENSION System we are used is the double wishbone system hence the axle remains full floating. The load came on axle is only torsional or driving force. From the view point of functionality the axle should have the rigidity at lower weight. If focused on the BAJA SAE INDIA event the ATV's are becoming less weight at same rigidity by optimizing designing and upgrading the material. The design is validate on the Ansys 14.5 to ensure the safety.

2. DESIGN METHODOLOGY

Different methodology for solving conditions can be appreciated based on the complexity of problem. The design of Half Axle was started only after studying the present design of drive train. We firstly studied the maximum torque required deliver by the engine, slippage at the CVT, reduction rpm in gear box and maximum torque available at the sun gear of the differential assembly. Simultaneously calculated the tractive effort required to drive the vehicle at various speed.

- Literature review for analysis is carried out by referring journal, books, manuals, and technical papers
- Appropriate material selection by analysis various material properties and compositions.
- The geometrical model is created by using the CATIA
- Stress analysis is carried out by using the ANSYS workbench

3. OBJECTIVE:

- To optimize the design which causes reduce weight hence will meet the BAJA event criteria.
- To study relevant analytical model of automotive drive shaft that are available in literature
- To create geometrical and FE model of drive shaft for dynamic analysis.
- To perform static analysis and so identify the stress concentration area of the drive shaft.

4. DESIGN:

The main objective of the transmission is providing to the driver more than the enough torque from engine to the wheels. The enough torque means the torque required to pull the driving wheel against the road loads. The road load includes Rolling resistance, Aerodynamic resistance, and Grade resistance. To choose the Half Axle for transmit the power from engine to the wheel it is necessary to calculate the dynamic load transfer on the axle.

3.1 Engine Specification

The vehicle performance is mainly depended on the two parameters i.e. Engine power and the maximum adhesive force between road and tire. The engine is provided by the BAJA event organizer of following specification.

Engine Type	Briggs and Stratton four stroke single cylinder 10 hp ohv intake
Engine Displacement	305 cc
Max Torque	19.2 N-m @2700 rpm
Max Power	10 HP @3250 rpm

3.2 Material Selection

As a recent development in the applications of materials have shown that alloy structural steel are used in power transmission can be a great assistance in overcoming a few of the problem faced with the conventional steel material. Good understanding of the drive shaft would be prerequisites and is discussed in following section.

A drive shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. Drive shafts are carriers of torque. They are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the stress, whilst avoiding too much additional

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weight as that would in turn increase their inertia. Therefore a drive shaft is expected to function as follows [6].

A. It must transmit the torque from differential gear box to the wheel.
B. The drive shaft must also be capable of rotating at very high speeds as required by the vehicle.
C. The drive shaft must also operate through constantly changing angles relative to the differential gear box and wheel.
D. The length of the drive shaft must also be capable of changing while transmitting torque.

So cope up with this functionality the material should have the following properties [3]

1. The material should have the high tensile strength, high modulus of rigidity, high modulus of elasticity, and high shear modulus.
2. The material should have the fatigue, wear and corrosion resistance.
3. The material should have the appropriate hardness for mating with gears

Review of design and performance requirement we dictate AISI 8620 single quenched and tempered steel material to be used. The material has the following properties.

Tensile Strength	1157 Mpa
Yield Strength	833 Mpa
Elastic modulus	190-210 Gpa
Bulk modulus	140 Gpa
Shear Modulus	80 Gpa
Poisson ratio	0.27
Rockwell hardness value	80

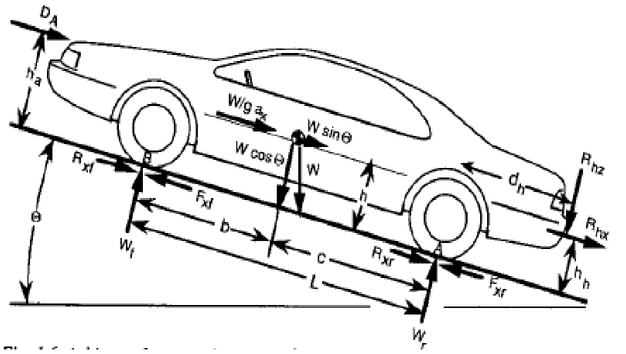
3.3 Analytical design

Determining the axle loading on a vehicle under arbitrary conditions is a simple application of Newton's Second law. It is an important first step in analysis of acceleration and braking performance because the axle load determines the tractive effort obtained at each axle, affecting the acceleration, gradeability, maximum speed and drawbar effort.
To calculate the tractive effort we required the prerequisites values which we already had defined. Let us take vehicle model with following specifications.

Gross vehicle weight	2650 N
Weight Distribution(Front: rear)	40:60
Tire Radius	0.292m
Coefficient of rolling radius	0.014
Coefficient of friction	1 (concrete)
Height of CG from ground	0.330m
Distance between Cg & stub axle	1.060m
Distance between Cg & half axle	0.725m
Max grade on road	30

The transmission system which we had designed is an automatic variable transmission which fixed reduction gear box with Continuous Variable Transmission (CVT). The gear box fixed reduction ratio is 15 and Continuous Variable Transmission (CVT) varies reduction from 0.4 to 3. Hence the maximum reduction ratio is 45

The load on the wheels is changes in the dynamic conditions. The main factor affects to change the load is acceleration [1]. The following graphical model shows the various load acting on the vehicle.



Dynamic load acted on the axle can be calculated as the following way
Total Load on Rear wheel = Dynamic load transfer on wheel + load due to the rolling resistance

Dynamic load transfer = $$w_r = \frac{w\, b\, cos\theta + \frac{w}{g} a_x h + w\, h\, sin\theta}{l}$$

To calculate the dynamic load transfer we firstly required the acceleration value,[1]

$$a_x = \frac{T_e \times R \times \eta \times g}{r \times w} \quad [2]$$

$$a_x = \frac{19 \times 45 \times 0.7 \times 9.81}{0.292 \times 2650} = 7.59$$

$$w_r = \frac{2650 \times 1.06\, cos30 + \frac{2650}{9.81} 7.5 \times 0.330 + 2650 \times 0.330 \times sin30}{1.785} = 3562.85$$

Load due to rolling resistance $= w \times c_r = 2650 \times 0.014 = 37.1$

Total load on rear wheel = 3562.85+37.1= 3599.95N
Load on single each axle= 1800N

Hence the diameter of axle can be calculated as [4][5]

$$T = \frac{\pi}{16} \times \tau \times d^3$$

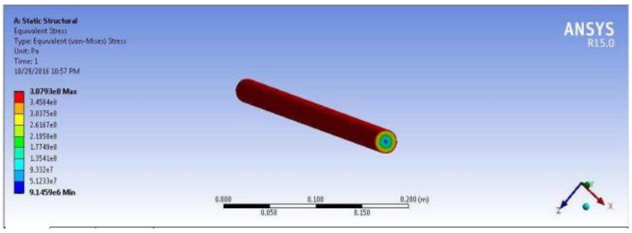
$$1800 \times 292 = \frac{\pi}{16} \times 587 \times d^3$$

$$d = 16$$

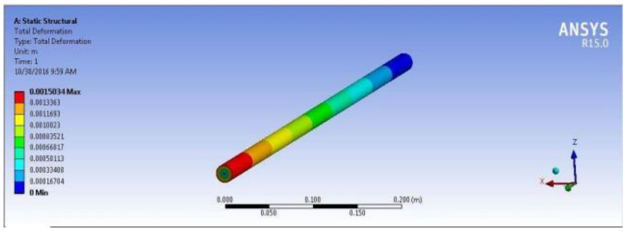
Take factor safety 1.2
Hence the **Diameter of the axle= 20 mm**

3.4 Modal Analysis:

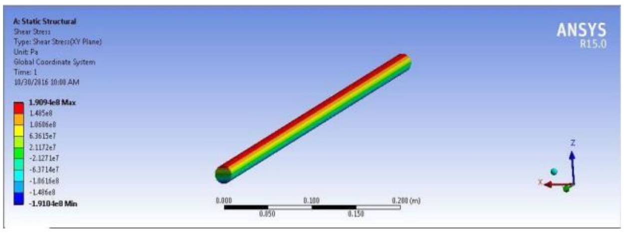
A good design solution can be delivered only after the function of the modal being test. A model analysis is performed by using Anasys. The analysis is used to determine the life, deformation and damage of model. Compared to homogeneous cylindrical shafts, the torsional behaviour of alloy shafts is considerably more complicated. The torsional rigidity not only depends on the global cross-sectional geometry, but also on the properties and configurations of each constituent [3]. The one end of the shaft is fixed and calculated torque is applied on other end. The behaviour of the shaft is shown below. The total 6696 nodes are meshed. The below Figures are shows the result.



3.4.1 Equivalent Stress



3.4.2 Total Deformation



3.4.3 Shear stress

5. CONCLUSION

The present work has resulted in various conclusions and also introduced scope for future work. The various conclusions that can be drawn from the project are listed below.

- Accurate representation of the dimension of component under analysis by adopting the reverse engineering technique.
- Static stress analysis reveals that the outer edge of the shaft is maximum stress concentration area. The maximum stress experienced by the drive shaft for the specified terrain and for the design load is 387 Mpa.
- Total Deformation of Half Axle is 0.0015m
- The maximum shear stress developed is 195 MPa.
- The maximum Static stress developed is 387 Mpa.
- Factor of Safety of the Half Axle is more than the 1 hence Half Axle is safe.
- The more stress is concentrate on the surface of the shaft hence required to heat treatment. Probably the case carburising process is most prepared. The depth of Case Carburising is 1 mm.[7]

REFERENCES

[1] Thomas G. Gillespie's, "Fundamental of Vehicle Dynamics," Published by "Society of Automotive Engineers, Inc".
[2] William F. Milliken and Douglas L. Milliken, "Race car Vehicle Dynamics," published by "Society of Automotive Engineers, Inc".
[3] Dr. V.D. Kodgire and Sushil V. Kodgire, "Material Science and Metallurgy," published by "Everest Publishing House".
[4] V. B. Bhandare, "Design of Machine Element," Published by "Tata McGraw Hill".
[5] R.S. Khurmi and G.K. Gupta, "Machine Design," Published By "S. Chand Publication House".
[6] Dr. Kirpal Singh, "Automobile Engineering", Published by "Standard Publishers Distributors".
[7] T.V.Rajan, C.P.Sharma, Ashok Sharma, "Heat Treatment Principles and Techniques", Published by "PHI Learning Private Limited".

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