PERFORMANCE AND ANALYSIS OF TRACTOR REAR AXLE SHAFT USING COMPOSITE MATERIALS

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ABSTRACT

Tractor is an off road vehicle which is considered to be any type of vehicle which is capable of driving on and off paved or gravel surface. Off road condition includes uneven agricultural field surfaces and bumpy village roads on which the tractor has to operate. Thus it is important to analyze rear axle shaft of tractor so that we can solve problems regarding breakdowns and failures during field operations. In this project, the material of the rear axle shaft is to be modified with composite materials and its corresponding mechanical properties were to determined using standard test methods as well as using softwares.

Keywords—*Rear axle shaft, Composite material, Agriculture field*

1. INTRODUCTION

An Axle shaft is a rotating member usually of circular cross-section (solid or hollow), which is used to transmit power and rotational motion in machinery and mechanical equipment in various applications. An axle is a central shaft for a rotating wheel. The wheel may be fixed to the axle, with bearings or bushings provided at the mounting points where the axle is supported. The axles maintain the position of the wheels relative to each other and to the vehicle body. Dead axle does not transmit power like the front axle, in a rear wheel drives are dead axles. On the dead axle suspension system is mounted, so it's also called suspension axle. Generally axle shafts are generally subjected to tensional stress and bending stress due to self-weight or weights of components or possible misalignment between journal bearings. Most shafts are subjected to fluctuating loads of combined bending and torsion with various degrees of stress concentration. For such shafts the problem is fundamentally fatigue loading. Eccentric Shaft is widely appreciated for its features like corrosion resistant, long service, effective performance and reliability. The primary purpose of Axle shaft is to act as power transmitting member from final drive to wheels. This is made possible by taking engine power through final drive component bull gear or planetary carrier according to type of final drive and then giving the same further through spline to axle shaft and to wheel through rim which is mounted on axle flange.

2.AIM OF PROJECT

The aim of the present work is to design, analyze on existing model and propose a model with change in shape and material.this is done to achieve the following.

- This design helps in the replacement of conventional rear axle shaft and casing with change of material for better corrosion resistant, long service, effective performance and reliability.
- To achieve substantial stress reduction in the shaft by replacing it with these materials.

3. COMPONENTS

In this concept, we are adding the three materials to be involved. They are

- Ductile cast iron
- E-glass
- Carbon fiber
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4. LITERATURE REVIEW

4.1 Evaluating For Rear Axle Housing Using Hybrid Aluminium Composites

Guruprasad.B,Arun.L, and Mohan.KDepartment of Mechanical Engineering, The Oxford College of Engineering, Bangalore.It is observed experimentally that the reinforced aluminium with Fly ash enhances mechanical properties in comparison with monolithic metal.The fatigue factor of safety is calculated for constant amplitude load varied from 1820 N to 91000 N. The fatigue factor of safety is calculated for fatigue strength corresponds to 8e5 cycles.

4.2 Analysis And Design Of Tractor Rear Axle Shaft Using Finite Element Method

Piyush. C. Chaudhari, Vimal. D. Sonara, and Dr.Pravin. P. Rathod1PG Scholar, Mechanical Engg. Department, Gov. Engg. college, Bhuj-370001, India, Presented paper on Analysis and Design of Tractor Rear Axle using Finite Element Method The axle shaft is likely to break at 144233 km whereas the warranty is for about 150000 km.Fractographic features indicated that fatigue was the main cause of failure of the axle shaft. It was observed that the fatigue cracks originated from welded areas.

4.3 Failure Analysis For Rear Axle Of Tractor With Loaded Trolley

A.K. Acharya et al.Failure analysis of rear axle of a tractor with loaded trolley" This paper describes the failure analysis of the rear axle at the root of the spline of a tractor with a loaded trolley used for haulage .The front wheel lifting and the failure of the rear axle at the root of the spline though mainly due to the transfer of weight, not sufficient attention. By reducing the hitching height and it was observed that by reducing the hitching height to 16.00 inches with reduction in the weight transfer factor by nearly 20%. G.K. Nanaware et al. Failures of rear axle shafts of 575 DI tractors "Studied on Rear axle shafts of 575 DI tractors manufactured by Mahindra and Mahindra Ltd".

5 SOFTWARE DESIGN

5.1 Design Of Rear Axle Shaft (Circular Section)

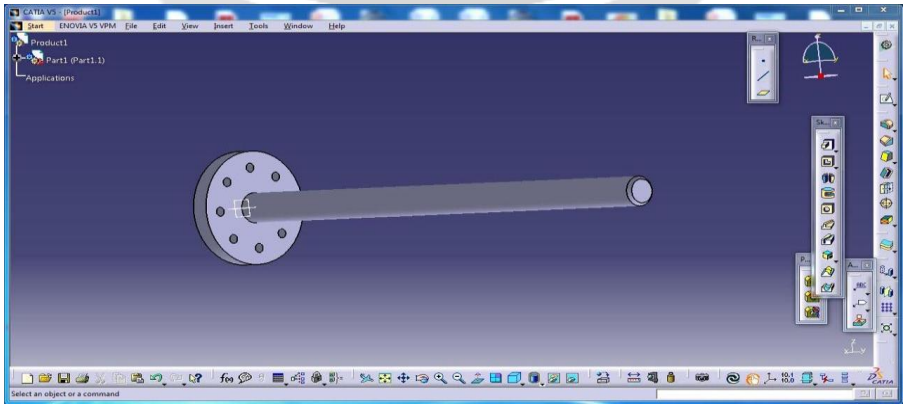

Fig.1 3D Design Of Rear Axle Shaft For Circular Section

5.2 3D Design Of Rear Axle Shaft (Hexagonal Section)

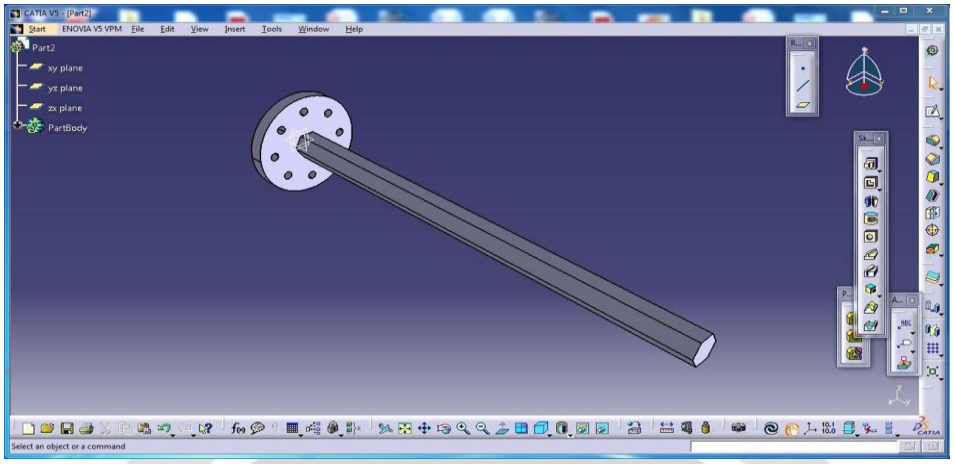

Fig.2 3D Design Of Rear Axle Shaft For Hexagonal Section

5.3 3D Design Of Rear Axle Shaft (I Section)

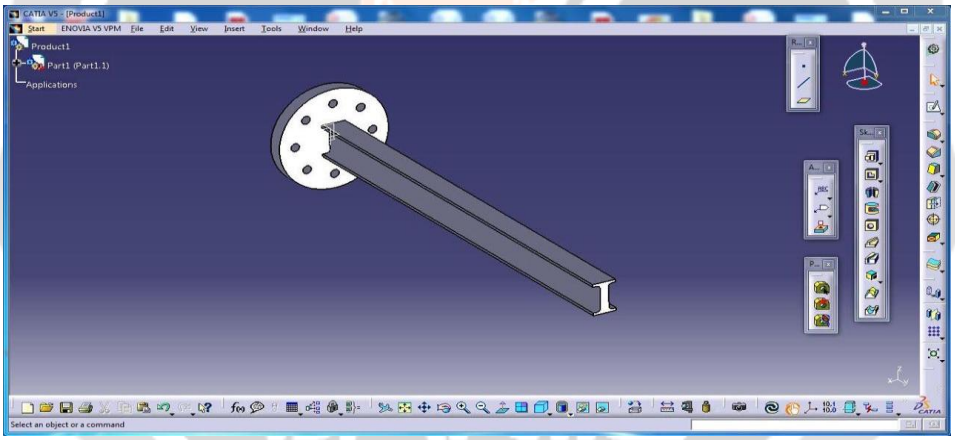

Fig.3 3D Design Of Rear Axle Shaft For I Section

6 CALCULATIONS

6.1 Engine Torque Calculation

Maximum speed of a tractor = 80 km/h

Length of the propeller shaft = 0.8m

Rotational Speed n = 2300 rpm

Maximum Horsepower P = 280HP i.e., 210 kW

Torque $T = P / 2 \pi n$

$= (210 \text{ kW}) (1000 \text{ W/kW}) / 2 \pi (2300 \text{ rev/min}) / (60 \text{ sec/min})$

=871.8 Nm

MAX Force on Differential Unit is

Force= Torque / Length

= 871.8/ 0.8

= 1.089 KN

6.2 Stress Calculations For Circular Shaft

Weight on each Rear Tyre (F) : 5000N

Length of Axle shaft : 0.800m

Diameter of the Shaft:0.05m

Stress:

$\sigma=F/A$

Area of the Shaft (A) = $2\pi rh + 2\pi Rh$

$=2*3.14*(0.05)*0.8 + 2*3.14*(0.19) *0.025$

=0.28103 Sq m

Therefore, Stress σ =5000/ 0.28103

$=0.17791*10^5$ Pa

7 ANALYSIS AND TEST RESULT

7.1 For Circular Section (Ductile Cast Iron)

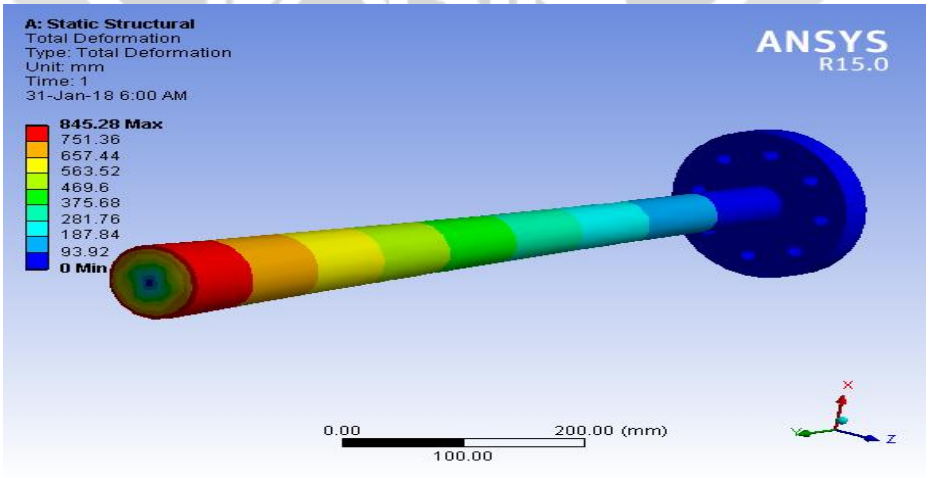

Fig.4 Deformation Analysis Image InAnsys(For Ductile Cast Iron)

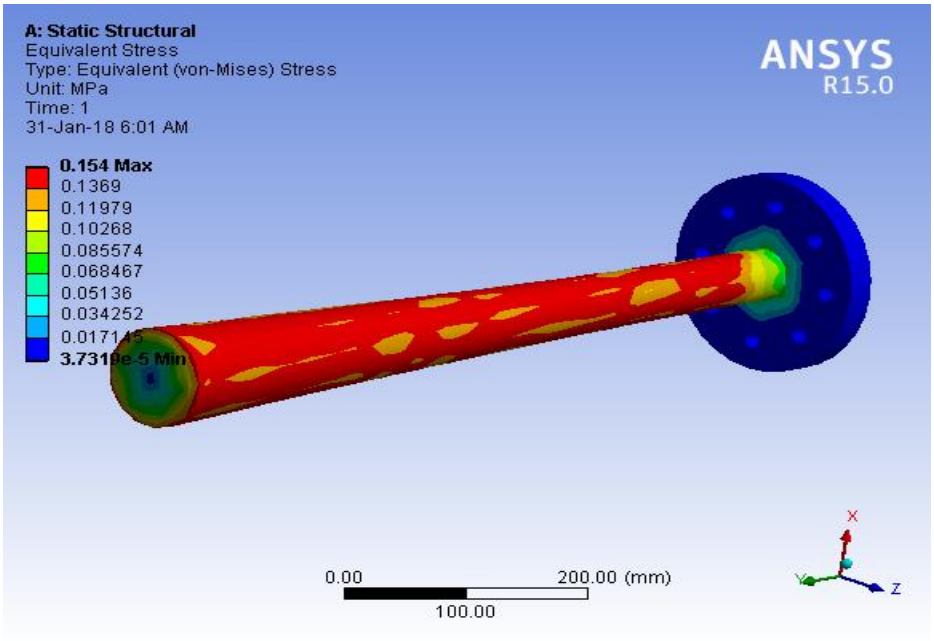

Fig.5 Stress Analysis Image In Ansys (For Ductile Cast Iron)

7.2 For Circular Section (For E-Glass)

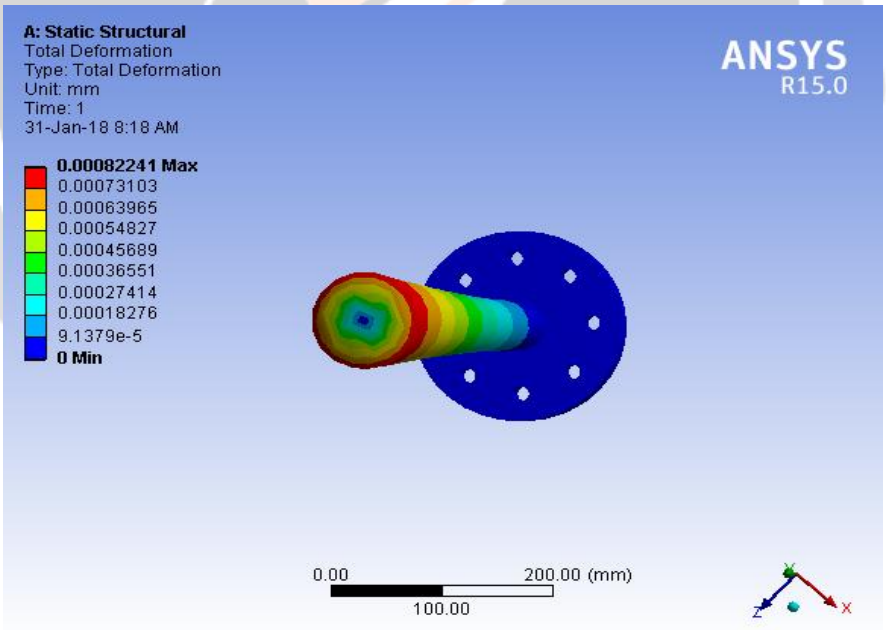

Fig.6 Deformation Analysis Image In Ansys (For E-Glass)

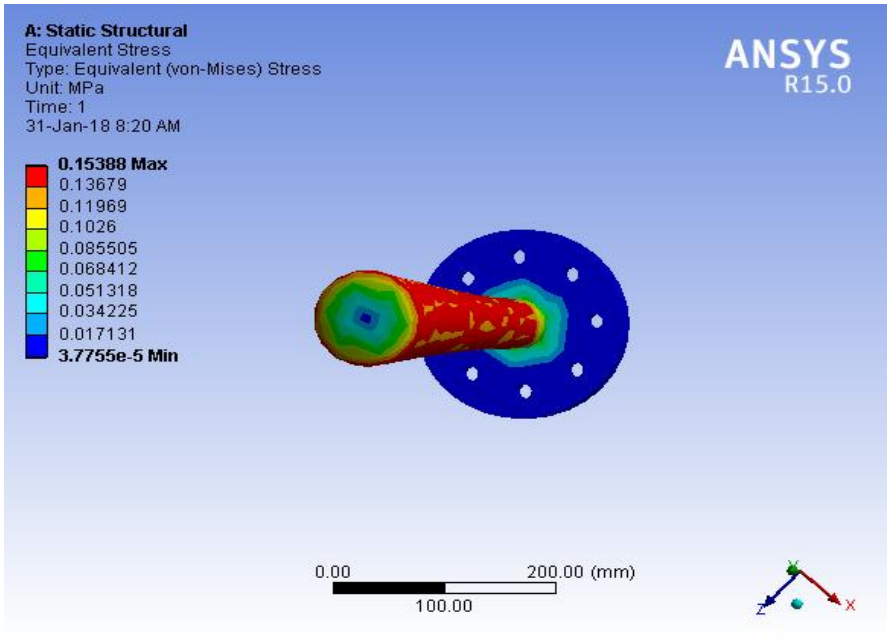

Fig.7 Stress Analysis Image In Ansys (for E-Glass)

7.3 For Circular Section (For carbon Fiber)

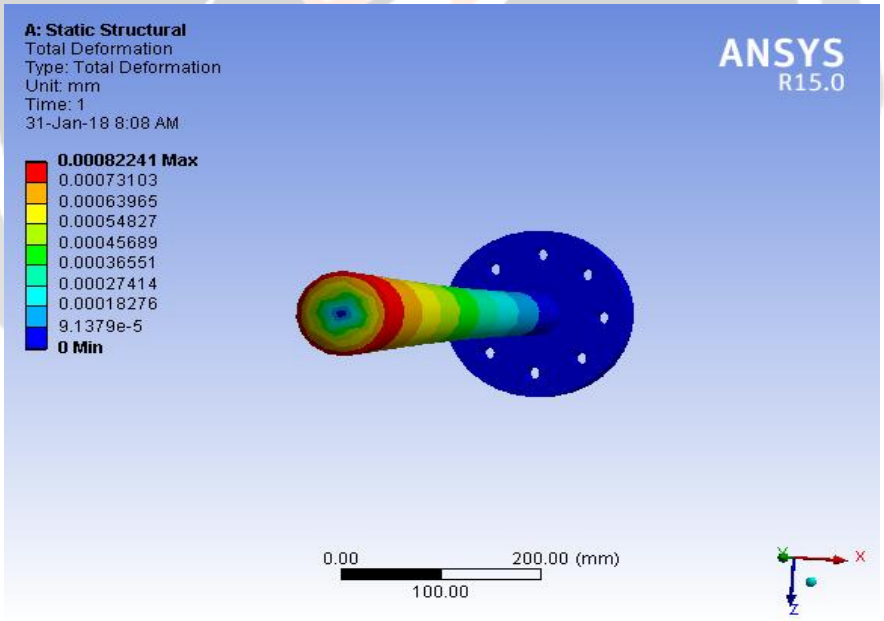

Fig.8 Deformation Analysis Image In Ansys (For Carbon Fiber)

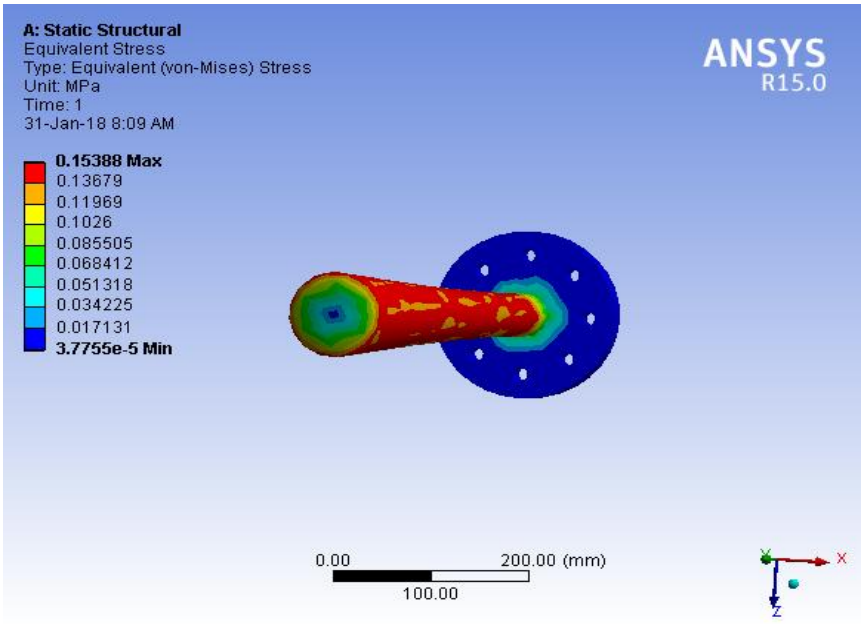

Fig.9 Stress Analysis Image In Ansys (For Carbon Fiber)

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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**

Product and Development Manager

8 PHOTOGRAPHIC VIEW

8.1 Front View Of Rear Axle Shaft

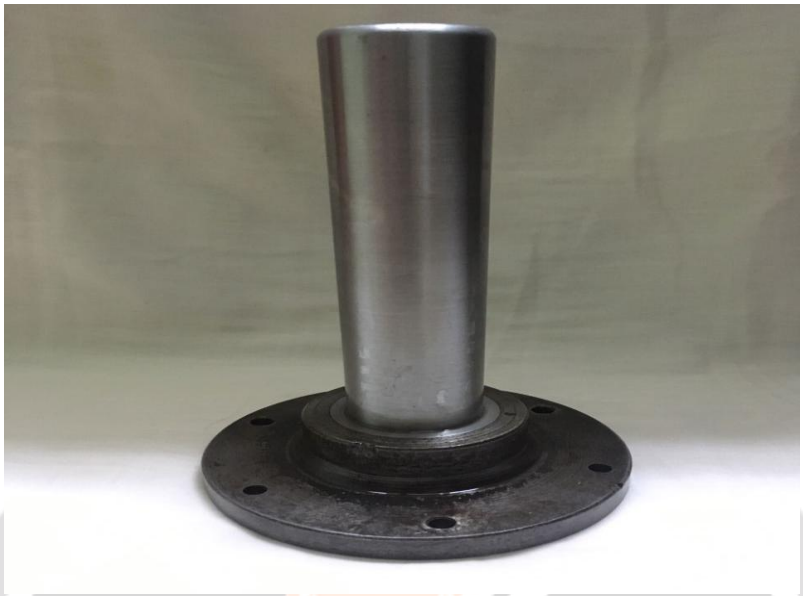

Fig.10 Front view

SCALE:

- TOTAL HEIGHT-27.5cm

8.2 Side View Of Rear Axle Shaft

Fig.11 Side View

SCALE:

- OUTER DIAMETER-16cm
- INNER DIAMETER-12.6cm
- HOLES-1cm
-

8.3 Top View Of Rear Axle Shaft

Fig.12 Top view

SCALE:

- INNER DIAMETER-5.2cm
- OUTER DIAMETER-16cm

9 CONCLUSION

Rear Axle shaft function and location in transmission layout discussed. Imperial approach for estimation of load case were possible established along within causing variation in final usage. These composite can be used for both static and dynamic applications like connecting rod, suspension arms, springs, rear axle housing etc. Thus we can optimize the rear axle shaft for increasing mechanical strength and easy manufacturability and change of material for better corrosion resistant, long service, effective performance and reliability. Hence to achieve the substantial stress reduction in shaft by replacing these materials.

10 REFERENCES

[1] Guruprasad. B, Arun. L, and Mohan. K. "Evaluating For Rear Axle Housing Using Aluminium Composites".

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