ANALYSIS AND DESIGN OF TRACTOR REAR AXLE SHAFT USING FINITE ELEMENT METHOD

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ABSTRACT: The world has immersed interest and investment in the automobile industry which affects their industries a great deal. Also, they are focusing on the development of vehicles with improve performance, increased stability, and enhanced driver pleasure. Due to their higher loading capacity, solid axles are typically used in the heavy commercial vehicles.

In this project the static analysis to determine the deformation, stress and strain with different materials steel, stainless steel and cast iron materials and modal analysis to determine the deformation with respect to frequency at different mode shapes. fatigue analysis to determine the life , damage and safety factor of the component at repeated cyclic load conditions.

3D modeling of tractor rear axle done in SOLID WORKS. Analysis done in ANSYS.

INTRODUCTION TO TRACTOR REAR AXLE

The word tractor originated from the Latin word “trahere”, meaning pull. Today, tractors are used for drawing in, towing or pulling objects that are extremely hard to move. The tractor on farms which is used to push agricultural machineries or trailers that plough or harrow fields. REAR AXLE CASING The rear axle is one of the components of the tractor which is present in the differential. Its main function is to transmit power from differential to wheel. This component is mounted on the back wheels of the tractor, so it is named as Rear Axle. The rear axle casing is the outer cover of the rear axle. Its main function is to protect the rear axle. The rear axle case is connected to 5 cases of transmission and has an inner peripheral surface, ring gear included in planetary reduction mechanism, ring gear being mounted on inner peripheral surface of rear axle case.

Agricultural tractors are used as a power source for various field operations such as planting, harvesting, tillage, transportation, through driving axles, and PTO devices [1]. The tractor consist of assembly of different parts like clutch housing, gear box housing, rear differential housing, brake housing and axle tube housing. The rear differential housing provides the outer cover for differential and other parts. The rear differential housing connected with gearbox housing at front and two axle tubes connected sidewise and fluid tight container hold the lubricant that baths those components. Thus an effective design of rear differential housing greatly increases the strength and life of the tractor. Transmission of a tractor is a component that takes about 25-30% of its total cost. Therefore, a proper design of transmission is important [2]. It is necessary to select the optimal gear to get better performance and durability of a tractor during field operation. Rear differential housing consists of special attachment provided to achieve 8 forward speeds of gearbox into 16 forward speed and 4 reverse into 8 reverse speed. By using this arrangement, numerous variation in torque and speeds for different work are carried out by the tractor. The second major component is differential used to divert power at 900 . In case of tractor, the differential is used to reduce speed by a greater extent i.e. 5.125:1. Another major component is PTO Shaft, which is used to take power from the tractor engine to run different implements like grass cutter, thrasher etc. All forces transmitted by PTO directly comes on rear differential housing. Last major component is three point hitches, which is provided to attach attachments of various configuration

REAR AXLE

A full-floating axle can be identified by a protruding hub to which the axle shaft flange is bolted. The semi-floating axle setup is commonly used on half-ton and lighter 4x4 trucks in the rear. This setup allows the axle shaft to be the means of propulsion, and also support the weight of the vehicle.

TYPES OF REAR AXLES

In rear wheel drive vehicles, the rear wheels are the driving wheels, whereas in the vehicles with front wheels drive the front wheels are the driving wheels. Almost all the rear axles in the modern cars are live axles, which mean that these axles move with the wheels, or revolve with the wheels and are known as live axles. Dead Axles are those axles which remain stationary and do not move with the wheels.

A.Semi-Float Axles

The Semi float axle is used in light trucks and passenger vehicle / buses. In the vehicles equipped with Semi Float

axle the shaft as well as the differential housing supports the weight of the vehicle. The wheel hub is directly connected to the axle shaft or is an extension of the same, the inner end of the axle shaft is spine and it is supported by the final drive unit.

B. Three-Quarter Floating

This is a compromise between the more robust full float axle and the simplest semi float type of axle. In Semi Floating axle the bearing is located between the axle casing and the hub instead of being between the axle casing and the shaft as in case of semi float axle. Three quarter floating axles were much popular for cases and lighter commercial vehicles.

C. Fully Floating Axle

Full Float Axle is considered as a robust one and is used for heavy vehicles / trucks meant to carry heavy loads. The axle shaft has flanges at the outer ends, which are connected to the flanged sleeve by means of bolts. There are two taper roller bearings supporting the axle casting in the hub, which take up any side load. Full Float axle is considered as the most heavy.

REAR AXLE CASING

Design of Existing Axle An axle is a stationary machine element and is used for the transmission of bending moment only. It simply act as a support for some rotating body such as hoisting drum and in tractor trolley case the axle is supporting of rotating member known as hub for holding the tires. So the axles are used to transmit bending moment only. Thus axles are designed on the basis of bending moment only

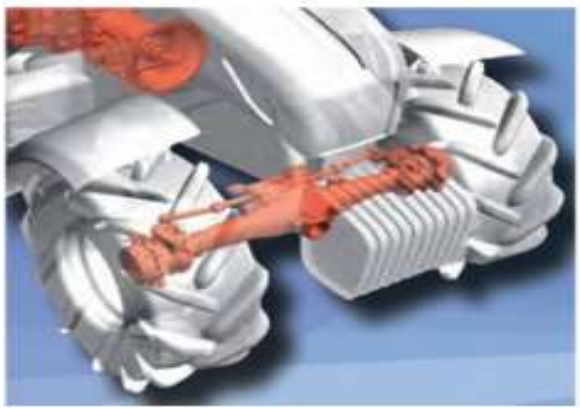


Fig: Rear axle casing

LITERATURE SURVEY

Static and dynamic analysis of front axle housing of tractor using finite element methods

MT250D Mitsubishi Tractor with 25hp power is a small agriculture tractor which is used to do light agricultural operations. In order to do off road operations, a front mounted mechanical shovel with total weight 400kg that including hydraulic equipment for example the weight of hydraulic cylinder was added on the front of the tractor and thus, the static weight on the front axle housing was increased. In this study, to do modeling of housing, Solid Works software (Version2010) was used. In order to use finite element method for static and dynamic analysis, Cosmos Works Software (Version 2010) was used. Finite element analysis results showed that the maximum stress of 238.84MPa is applied on the upper housing. According to Von-Misses theory, the value of maximum applied stress and allowable stress, the safety factor of 1.05 was obtained which is less than the required value. The first four natural frequencies of housing were found as 678.54, 720.29, 908.78 and 1877 Hz, respectively. The obtained factor of safety is very low and obviously this value decreases under dynamic loading conditions of field operation. The present study clearly indicates that the front axle housing of MT250D Mitsubishi tractor is not strong enough to be mounted on a tractor. There is a need to optimize the existing design of the front axle housing, if we want to use a mechanical shovel. Abbreviations: σ _stress (MPa); σ 1 ,σ 2 ,σ 3 _principal stresses (MPa); f_ frequencies (Hz);V i _ tractor speed (m/s); g _Gravity(m 2 /s); h_ fall height (m); T r _ rise time (s); h′ _ tire compression (m); F max _ maximum value of dynamic load (N); M f _ applied static mass (kg); Δv i_ tractor speed (m/s); Δt_ rise time (s).

INTRODUCTION TO CAD

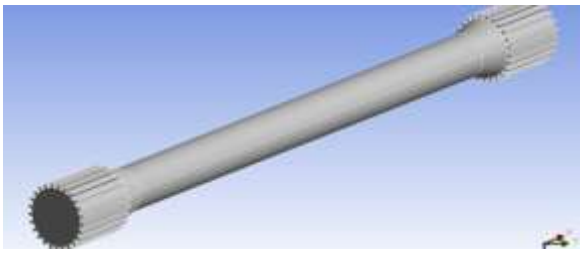
Computer-aided design (CAD) is that the use of pc systems (or workstations) to help within the creation, modification, analysis, or improvement of a style. CAD package is employed to extend the productivity of the designer, improve the standard of style, improve communications through documentation, and to form an info for producing. CAD output is usually within the type of electronic files for print, machining, or alternative producing operations. The term CADD (for pc assisted style and Drafting) is additionally used.

INTRODUCTION TO SOLID WORKS

SolidWorks (stylized as SOLIDWORKS) is a strong modeling computer-aided layout (CAD) and laptop-aided engineering (CAE) computer application that runs on Microsoft Windows. SolidWorks is published with the aid of DassaultSystèmes.

According to the writer, over million engineers and architects at extra than 165,000 corporations were the use of SolidWorks as of 2013. Also in line with the organization, financial year 2011–12 revenue for SolidWorkstotalled $483 million.

3D MODEL



INTRODUCTION TO FEA

Finite Element Analysis may be a technique of finding, sometimes roughly, sure issues in engineering and science. It's used primarily for issues that no precise resolution is required. Mainly used in some mathematical modeling of a structure or member in design or thermal analysis. Strategies of this kind area unit required as a result of analytical strategies, sophisticated issue that are used in engineering. For instance, in engineering strength of materials or the mathematical theory of snap are often want to calculate analytically the stresses and strains during a bent beam.

ANSYS Mechanical

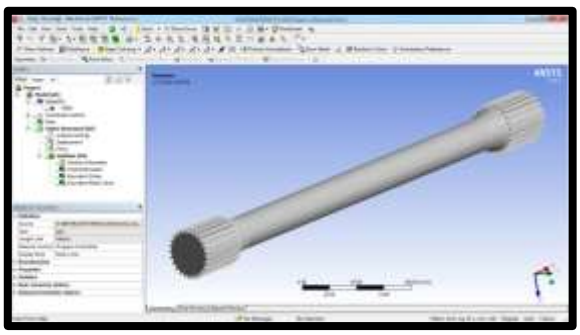
ANSYS Mechanical may be a finite part analysis tool for structural analysis, as well as linear, nonlinear and dynamic studies. This framework product provides finite parts to model behavior, and supports material models and equation solvers for a good vary of mechanical style issues. ANSYS Mechanical conjointly includes thermal analysis and coupled-physics capabilities involving acoustics, electricity, thermal–structural and thermo-electric analysis.

STATIC ANALYSIS OF TRACTOR REAR AXLE

Definition of Static Analysis

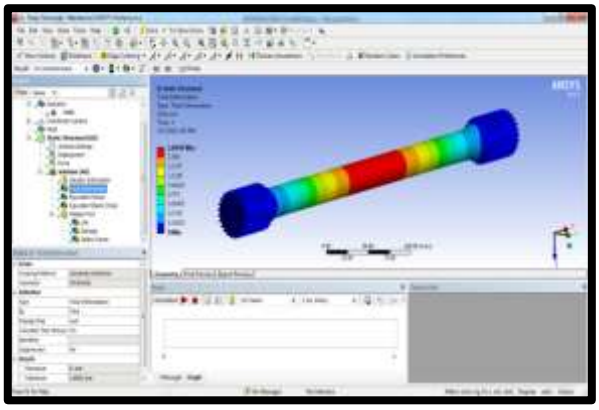
A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonly defined in many building codes).

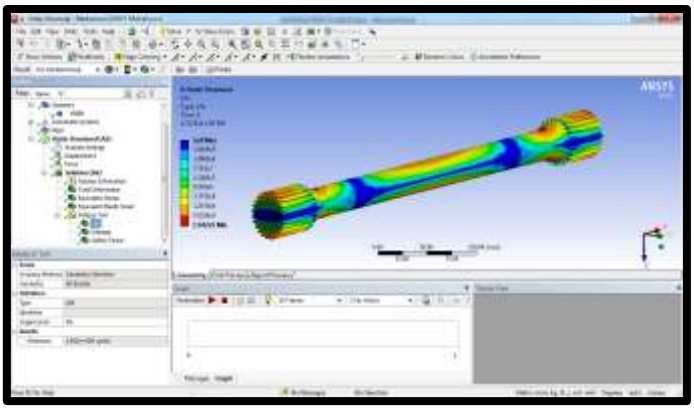
Imported model



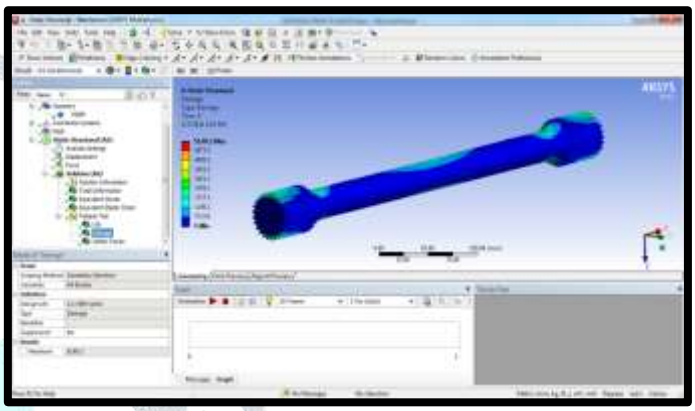
MATERIAL: CAST IRON

Deformation:

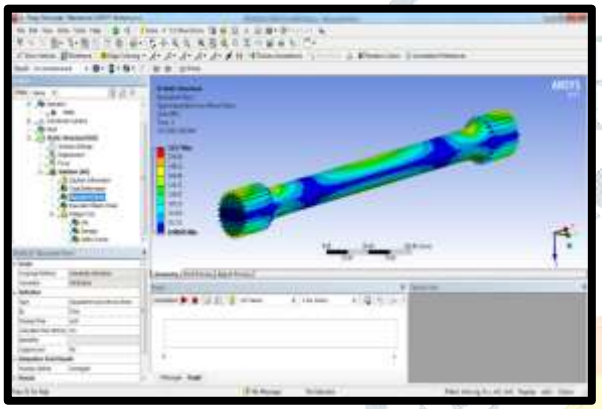




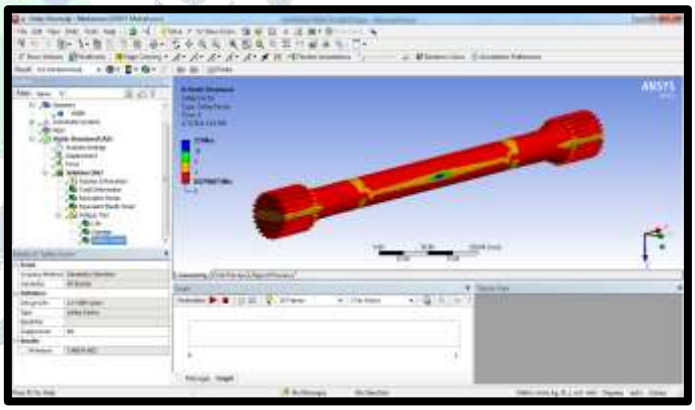
Damage:



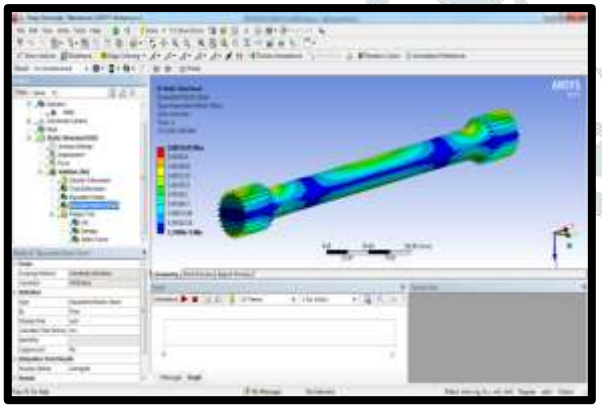
Stress:



Safety factor:



Strain:



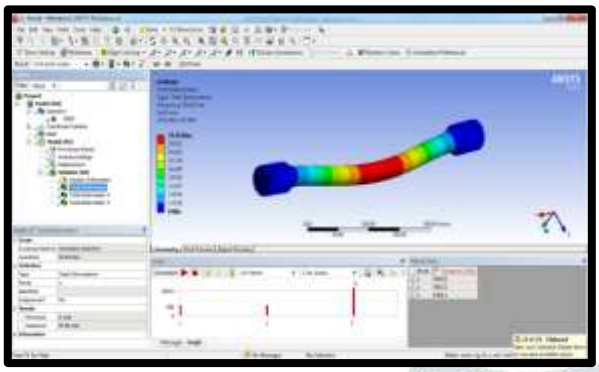
FATIGUE ANALYSIS OF TRACTOR REAR AXLE

Life:

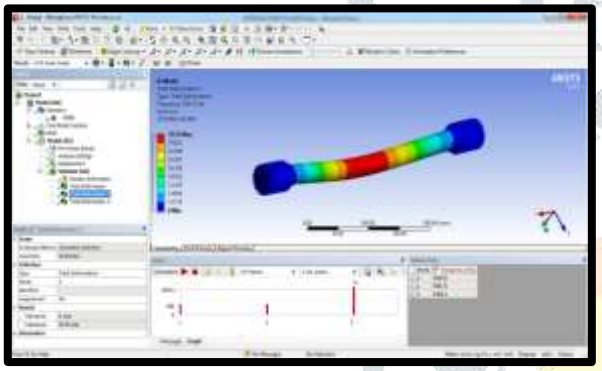
MODAL ANALYSIS OF TRACTOR REAR AXLE

MATERIAL: CAST IRON

Total Deformation1:



Total Deformation2:



Total Deformation3:

MATERIAL	Deformation (mm)	Stress (N/mm²)	Strain
STEEL	0.8467	315.1	0.0015918
CAST IRON	1.6942	313.7	0.0031643
STAINLESS STEEL	0.87716	315.64	0.001654

Fatigueanalysisresults:

MATERIAL	Life	Damage	Safety factor	
			Min	Max
STEEL	1e9	5206.3	0.07935	15
CAST IRON	1e9	5149.2	0.07968	15
STAINLESS STEEL	1e9	5228.8	0.07919	15

Modal analysis results:

MATERIAL	Mode shapes	Deformation (mm)	Frequency (Hz)
STEEL	1	32.15	718.27
	2	32.14	719.17
	3	29.722	1813.34
CAST IRON	1	33.56	556.02
	2	33.55	556.72
	3	31.014	1404.1
STAINLESS STEEL	1	32.36	710.26
	2	32.352	711.15
	3	29.923	1793

Stress plot:

RESULT TABLE: Analytical Investigation

Static analysis results:

CONCLUSION

In this project the static analysis to determine the deformation, stress and strain with different materials steel, stainless steel and cast iron materials and modal analysis to determine the deformation with respect to frequency at different mode shapes. fatigue analysis to determine the life , damage and safety factor of the component at repeated cyclic load conditions.

By observing the static analysis the minimum stress value at cast iron material when we compare the steel and stainless steel.and deformation, strain maximum values at cast iron material.

By observing the fatigue analysis the safety factor maximum value at cast iron material.

By observing the modal analysis the deformation maximum value at cast iron material frequency minimum values at cast iron material.

So it can be concluded the cast iron material. is the better material for tractor rear axle.

BIBILOGRAPHY

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