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Design And Analysis Of Differential Gear Box

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Abstract:

Differential is used when a vehicle takes a turn, the outer wheel on a longer radius than the inner wheel. The outer wheel turns faster than the inner wheel that is when there is a relative movement between the two rear wheels. If the two rear wheels are rigidly fixed to a rear axle the inner wheel will slip which cause rapid tire wear, steering difficulties and poor load holding.Differential is a part of inner axle housing assembly, which includes the differential rear axles, wheels and bearings. The differential consists of a system of gears arranged in such a way that connects the propeller shaft with the rear axles. The main objective of this paper is to perform mechanical design of differential gear box and analysis of gears in gear box. We have taken Stainless steel,aluminium alloy,magnesium alloy,structural steel materials for conducting the analysis. Presently used materials for gears and gears shafts is Cast Iron, Cast Steel. So, in this paper we are checking as the other material for the differential gear box for light utility vehicles so, we can reduce the weight.

Keywords- *Chassis, Finite element Analysis, Structure, Ladder Frame, Static structural analysis, Side Member, Cross Member.*

1.Introduction

A transmission or gearbox provides speed and torque conversions from a rotating power source to another device using gear ratios. In British English the term transmission refers to the whole drive train, including gearbox, clutch, prop shaft (for rear-wheel drive), differential and final drive shafts. In American English, however, the distinction is made that a gearbox is any device which converts speed and torque, whereas a transmission is a type of gearbox that can be "shifted" to dynamically change the speed: torque ratio, such as in a vehicle. The most common use is in motor vehicles, where the transmission adapts the output of the internal combustion engine to the drive wheels. Such engines need to operate at a relatively high rotational speed, which is inappropriate for starting, stopping, and slower travel. The transmission reduces the higher engine speed to the slower wheel speed, increasing torque in the process. Transmissions are also used on pedal bicycles, fixed machines, and anywhere else rotational speed and torque needs to be adapted

Differential gearbox

A differential is a device, usually but not necessarily employing gears, capable of transmitting torque and rotation through three shafts, almost always used in one of two ways: in one way, it receives one input and provides two outputs this is found in most automobiles and in the other way, it combines two inputs to create an output that is the sum, difference, or average, of the inputs. In automobiles and other wheeled vehicles, the differential allows each of the driving road wheels to rotate at different speeds, while for most vehicles supplying equal torque to each of them.

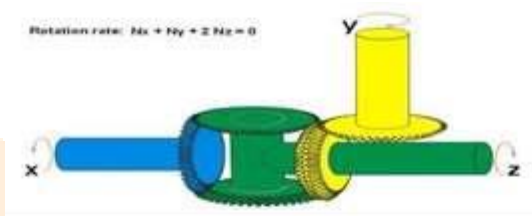

fig 1.1 differential gear box

Definition of the Problem

Leading manufacturers of gearbox, which are used in various utensil and sugar mill machinery, faced the following problems

- Interference
- Surface
- Fatigue Fracture

The gears fail when tooth stress exceeds the safe limit. Therefore, it is essential to determine the maximum capacity under a specified loading. Analysis of gears is carried to reduce stress that a gear tooth is subjected to, to figure out so that these can be prevented from failure.

When failure occurs, they are expensive not only in terms of the cost of replacement or repair but also the cost associated with the downtime of the system of which they are a part.

2.Methodology:

The modeling and stress analysis of the gearbox has been done in solid works and ANSYS respectively.

Materials used for differential gearbox:

stainless steel

Aluminium Alloy

Magnesium alloy

structural steel

Design parameters

PROPELLER SHAFT

Gears are assembled and mated in this shaft

Part	Diameter	Teeth
Ring gear	150mm	50
Pinnion gear	70mm	25
Planet gear	50mm	20
Side gear	50mm	18

Design of differential gearbox in solidworks:

fig 2.1 pinnion gear

fig 2.2ring gear

fig 2.3 side gear

fig 2.4 planet gear

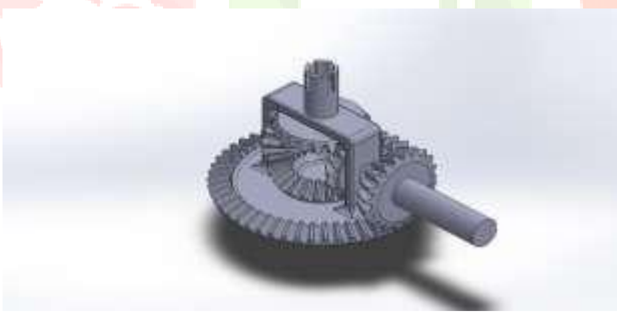

fig 2.5 assembly of differential gearbox

Introduction to Structural (Static) Analysis:

With the widespread adoption of CAE approach to design, finite element analysis became integrated with the design and analysis procedure. Structural (Static) analysis is used to analyze parts and assemblies to find,

Maximum Stresses

Deformed Shapes (Deformation

Analysis in ansys workbench 16.1:

Geometry:

The modelling done in solidworks is saved in stp format and is imported in ansys software.

Automatic Mesh Generation:

Mesh generation is one of the most critical aspects of engineering simulation. ANSYS Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible

Analysis: Structural steel:

Young's modulus = 2e^11Pa Poisson's ratio = 0.28

Tensile strength = 4.13613e^8 N/m^2 Density = 7800 kg/m3

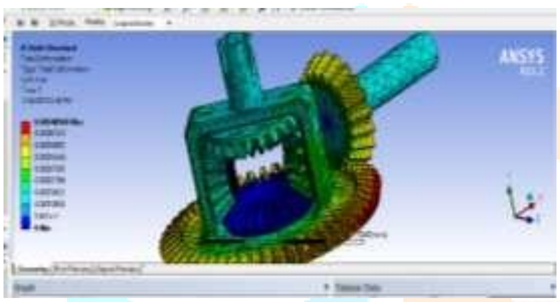

fig 2.6 total deformation

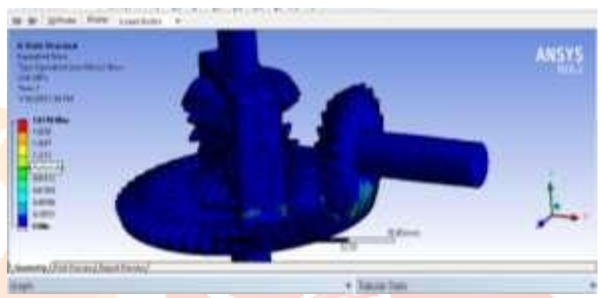

fig 2.7 von mises stress

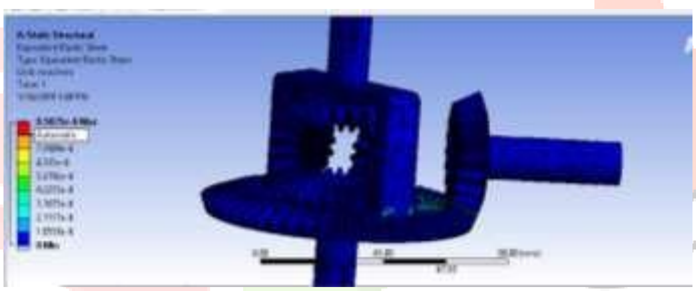

fig 2.8 elastic strain

Aluminium alloy:
Young's modulus = 7e^10Pa Poisson's ratio = 0.33
Tensile strength = e+007 N/m^2 Density = 2600 kg/m^3

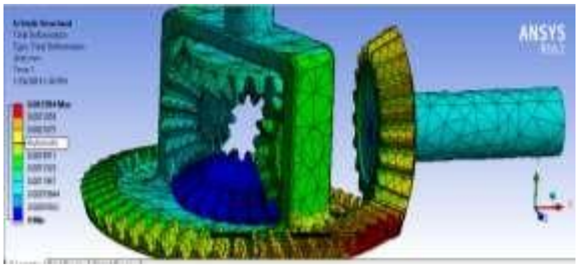

fig 2.9 total deformation

fig 2.10 von mises stress

fig .2.11elastic strain

Magnesium alloy:
Young’s modulus = 7e^10Pa Poisson’s ratio = 0.35
Tensile strength = 1.93e^8 N/m^2 Density = 1800 kg/m^

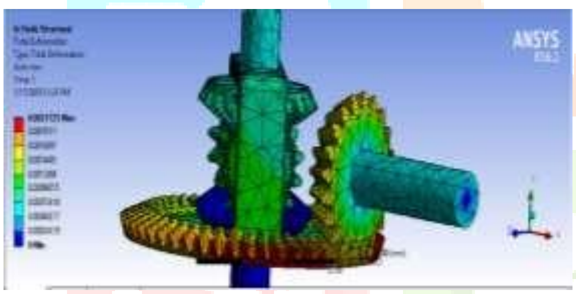

fig 2.12 total deformation

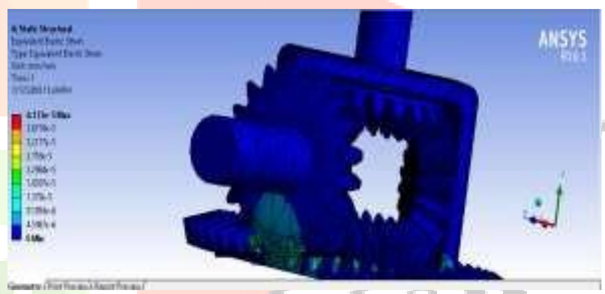

fig 2.13 von mises stress

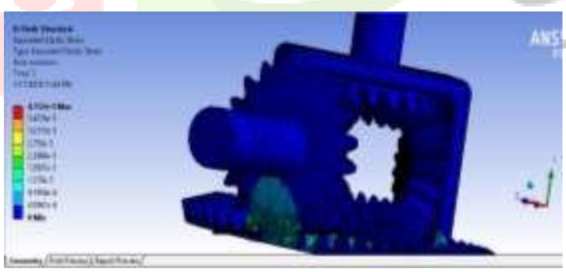

fig 2.13 elastic strain

stainless steel:

Young’s modulus = 1.93e^11Pa Poisson’s ratio = 0.31

Tensile strength = 2.4e^8 N/m^2 Density = 7750 kg/m^3

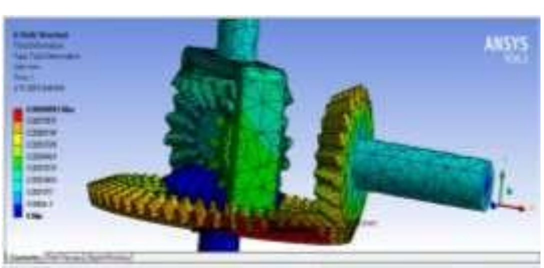

Fig.2.14Total deformation

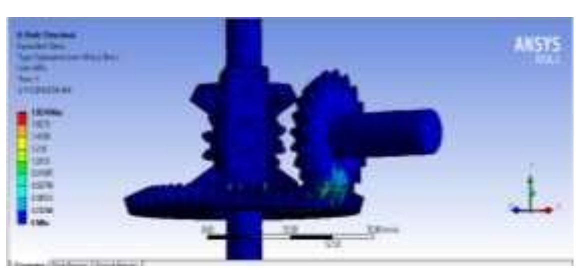

Fig.2.15 Von mises stress

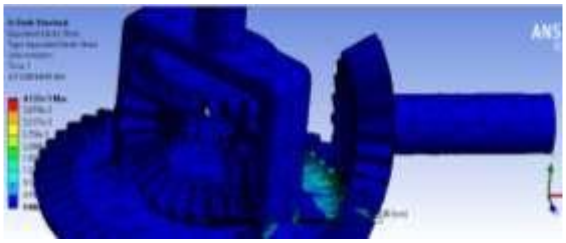

fig 2.16 elastic stress

Comparison of results:

S.NO	MATERIAL	DEFORMATION	STRESS(pa)	STRAIN(kg/m3)
1	ALUMINIUM ALLOY	3.582	4.5558	6.852
2	STAINLESS STEEL	3.458	2.456	3.456
3	MAGNESIUM ALLOY	2.1725	1.824	4.137
4	STRUCTURAL STEEL	4.8965	1.8318	9.502

Conclusion:

In this project, a differential gearbox is modelled in 3D modelling software solidworks 16 and theoretical calculations and also static is done by using ANSYS Workbench 16.0. Present used material for differential gearbox is cast iron. In this project, it is replaced with Gray cast iron, magnesium alloy, Aluminium Alloy , and structural steel .Has been selected for static Anaysis has been done to find the total deformation, equivalent stress and equivalent elastic strain. by comparing the results it is clear that magnesium alloy has less deformation than other materials, So using the materials is safe. And by comparing the Theoretical Calculations between materials, magnesium alloy is more advantageous than other materials due to its less weight and high strength.

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