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Design And Simulation Of Rotary Power Steering System

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Abstract: **The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver, via the steering column, which may contain universal joints (which may also be part of the collapsible steering column design), to allow it to deviate somewhat from a straight line. In this thesis, to turn the rear wheels out of phase to the front wheels. In order to achieve this, a mechanism which consists of two bevel gears and intermediate shaft which transmit 100% torque as well turns rear wheels in out of phase was developed. The materials used for these analyses are Aluminum alloy, steel, and cast iron materials. Static analysis to determine the deformation, stress of the steering system at different rotational velocities (220,250,300&400rad/s), modal analysis to determine the natural frequency and deformation for 5 mode shapes. 3D modeled by using the software Pro-Engineer and analysis done in ANSYS software.**

Keywords: **Pressure Vessel; Weld Efficiencies; CREO; ANSYS; Linear Layer Analysis;**

I. INTRODUCTION

Steering is the collection of additives, linkages, etc. Which allows any automobile (automobile, motorcycle, bicycle) to follow the desired course. An exception is the case of rail delivery by which rail tracks mixed together with railroad switches (and also called 'points' in British English) provide the steerage characteristic. The number one purpose of the steerage device is to allow the motive force to manual the vehicle.

Fig.1 tire

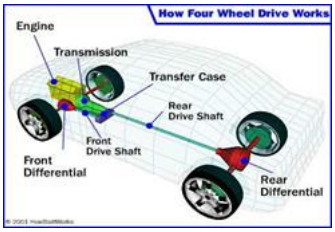
Types of Steering System:

Conventional Steering System:

In that guidance gadget, only the the front wheels are urged closer to right or left According to the Requirement because of at rear their useless axle is present.

Four Wheel Steering System:

In that steerage machine, the all four wheels are to be instructed in step with the steer perform to pressure toward left or right. Four-wheel steerage, 4WS, also called rear-wheel steering or all-wheel guidance, offers a method to actively steer the rear wheels at some point of turning maneuvers. It ought to not be stressed with 4-wheel pressure wherein all 4 wheels of a vehicle are powered. It improves coping with and allows the vehicle make tighter turns. Production-constructed automobiles have a tendency to under steer or, in few times, over steer. If a car ought to mechanically atone for an underneath steer /over steer hassle, the driver would enjoy almost neutral steering beneath various situations. In most lively four wheel steerage machine, the rear wheels are instructed by way of a computer and actuators, the rear wheels typically cannot flip as some distance as the the front wheels.



There are 3 kinds of manufacturing of 4-wheel ¬steerage systems:

1. Mechanical 4WS
2. Hydraulic 4WS
3. Electro/hydraulic 4WS

The mechanical 4WS makes use of separate steerage gears to manipulate the front and rear wheels. The hydraulic 4WS uses a -manner hydraulic cylinder to show both the wheels in the identical path. It isn't always viable to show them within the contrary course. The electro/hydraulic 4WS combine laptop digital controls with hydraulics to make the gadget touchy to both steerage perspective and street speeds.

ADVANTAGES

1. Computer-controlled Quadra steer can be switched on and rancid and has an effective trailer towing mode.

2. A laptop determines how tons and in which course the rear wheels need to flow, and whether or not the rear wheels should flip the identical route as

the the front wheels or inside the opposite path. The motion is variable as much as more than one inches.

3. At slow speeds, the rear wheels circulate the opposite direction of the front wheels. This makes for simpler parking and maneuvering.

4. At highway speeds, the rear wheels flow inside the same route because the the front wheels for simpler lane changing. If you're pulling a trailer you'll simply appreciate this selection, because it permits your car to alternate lanes with out the snaking-effect you'd commonly revel in.

5. In order to accommodate the steerage mechanism and wheel movement, the Sierra Denali's song and fender width are wider than its traditional counterpart, but it's now not as extensive because the rear of a dually pickup

DISADVANTAGES OF 4WS VEHICLES

1. Significantly growth in work load for the front tires.

2. Large amount of left/proper weight switch seen in 4ws vehicle.

3. Uneven tires put on of front and rear wheels.

II. LITERATURE SURVEY

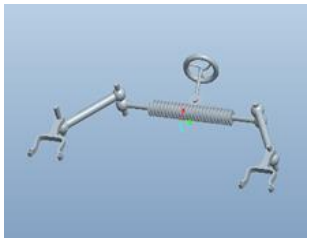
1. Four-wheel steerage gadget for Automobile

A Four-wheel guidance machine also referred to as Quadra steering machine. In this paper, each the front wheel and rear wheels may be prompt in line with speed different vehicle and area available for turning. Quadra steer offers complete length automobile greater ease even as riding at low velocity, improves stability, coping with and manage at better pace. Production-constructed cars generally tend to beneath steer or, in few times, overseer. If a automobile may want to automatically compensate for an underneath steer overseer hassle, the driver could enjoy nearly neutral steerage underneath various situations. Four wheel systems is a severe effort on the a part of car layout engineers to offer close to-impartial guidance. This system finds application in off-highway automobiles together with forklifts, agricultural and construction system mining machinery also in Heavy Motor Vehicles. It is likewise useful in passenger motors. It improves handling and helps the automobile make tighter turns. This system is used to decrease the turning radius. KEYWORDS: Quadra, turning radius, cornering, natural

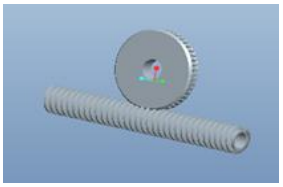
III. INTRODUCTION TO CREO

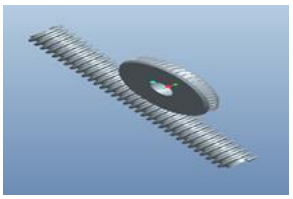
PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule-based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself. It has many advantages like Optimized for model-based enterprises, Increased engineer productivity, Better enabled concept design, Increased engineering capabilities, Increased manufacturing capabilities, Better simulation, Design capabilities for additive manufacturing.

3D MODAL OF FOUR WHEELER STEERING SYSTEM



Gear system





INTRODUCTION TO FINITE ELEMENT METHOD

Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

ANSYS Software:

ANSYS is an Engineering Simulation Software (computer aided Engineering). Its tools cover Thermal, Static, Dynamic, and Fatigue finite element analysis along with other tools all designed to help with the development of the product. The company was founded in 1970 by Dr. John A. Swanson as Swanson Analysis Systems, Inc. SASI. Its primary purpose was to develop and market finite element analysis software for structural physics that could simulate static (stationary), dynamic (moving) and heat transfer (thermal) problems. SASI developed its business in parallel with the growth in computer technology and engineering needs. The company grew by 10 percent to 20 percent each year, and in 1994 it was sold. The new owners took SASI's leading software, called ANSYS®, as their flagship product and designated ANSYS, Inc. as the new company name.

IV. STATIC ANALYSIS OF FOUR WHEELER STEERING SYSTEM

USED MATERIALS

STEEL, ALUMINUM ALLOY AND CAST IRON

MATERIAL PROPERTIES

STEEL

Density = 7.89g/cc

Young's modulus = 205000MPa

Poisson's ratio = 0.29

ALUMINUM ALLOY

Density = 2.7g/cc

Young's modulus = 68900MPa

Poisson's ratio = 0.3

CAST IRON

Density = 7.81g/cc

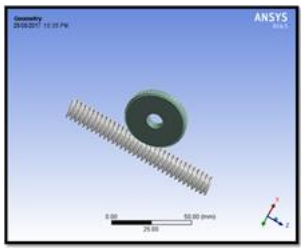
Young's modulus = 230 MPa

Poisson's ratio = 0.31

Used software for this project work bench

Open work bench in Ansys 14.5

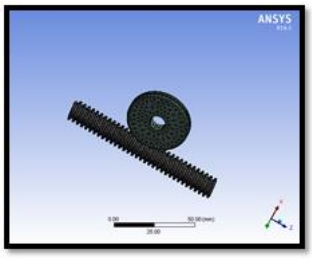
Select static structural>select geometry>import IGES model>OK



Click on model>select EDIT

Select model >apply materials to all the objects (different materials also)

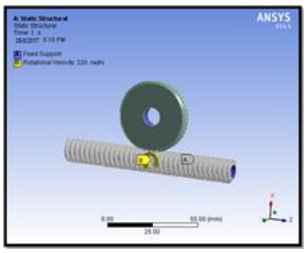
Mesh> generate mesh>ok



Static structural A5>insert>select .displacement>select fixed areas>ok

>Select pressure>select pressure areas> enter pressure value

>Select rotational velocity>select axis>enter speed value



Solution A6>insert>total deformation>right click on total deformation>select evaluate all results

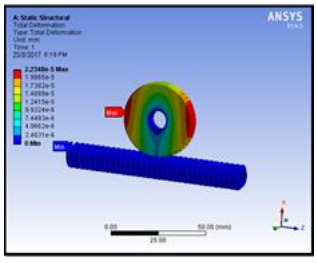
Insert>stress>equivalent (von misses)>right click on equivalent >select evaluate all results

Insert>strain>equivalent (von misses)>right click on equivalent >select evaluate all results

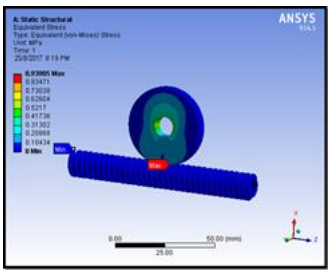
ROTATIONAL VELOCITY 220rad/s

MATERIAL- STEEL

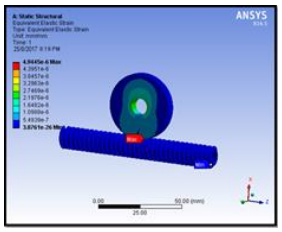
DEFORMATION



STRESS

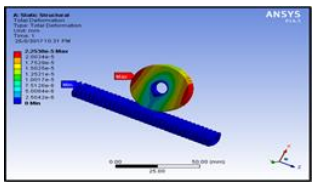


STRAIN

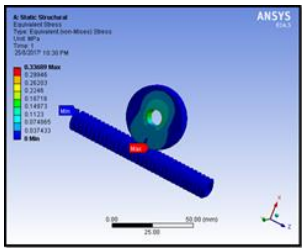


MATERIAL- ALUMINUM ALLOY

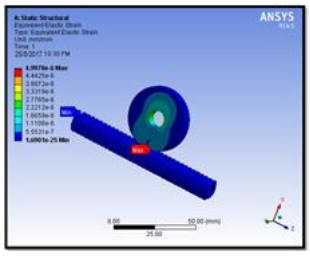
DEFORMATION



STRESS



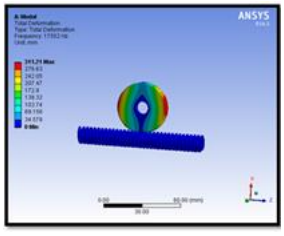
STRAIN



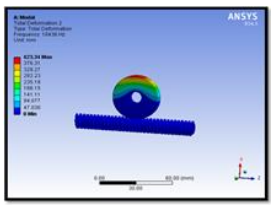
MODAL ANALYSIS OF FOUR WHEELER STEERING SYSTEM

MATERIAL- STEEL

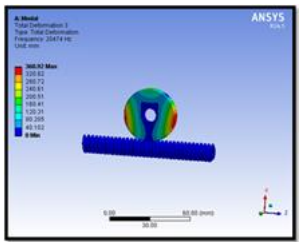
1st mode shape deformation



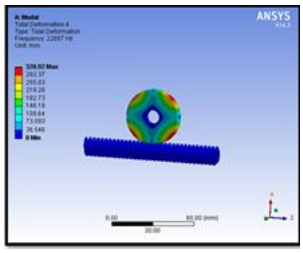
2nd mode shape deformation



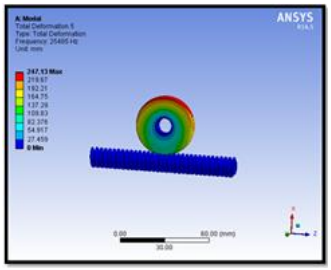
3rd mode shape deformation



4rth mode shape deformation

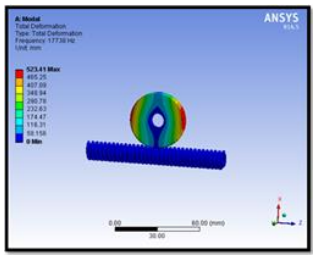


5th mode shape deformation

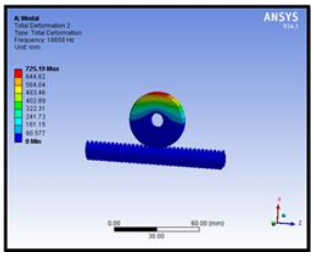


MATERIAL- ALUMINUM ALLOY

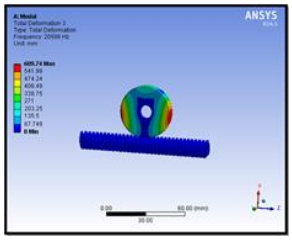
1st mode shape deformation



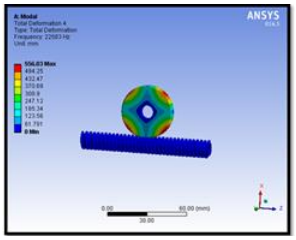
2nd mode shape deformation



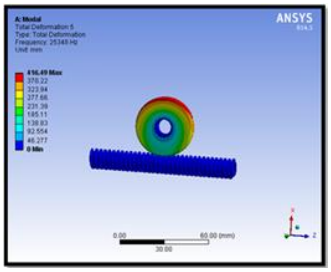
3rd mode shape deformation



4rth mode shape deformation



5th mode shape deformation



V. STATIC ANALYSIS RESULT TABLE

material	Rotational velocity(rad/s)	Deformation(mm)	Stress(MPa)	strain
steel	**220**	2.2348e-5	0.93905	4.9445e-6
	250	2.8858e-5	1.2126	6.3849e-6
	300	4.1556e-5	1.7402	9.194e-6
	400	7.3877e-5	3.1043	1.6345e-5
Aluminum alloy	**220**	2.2538e-5	0.33689	4.9978e-6
	250	2.9104e-5	0.43504	6.4537e-6
	300	4.1909e-5	0.62646	9.293e-6
	400	7.4505e-5	1.1137	1.6522e-5
Cast iron	**220**	3.6893e-5	0.85185	8.1545e-6
	250	4.7641e-5	1.11	1.053e-5
	300	6.8603e-5	1.584	1.5163e-5
	400	0.00012196	2.816	2.6957e-5

MODAL ANALYSIS RESULT TABLE

material	Mode shapes	Deformation(mm)	Frequency (Hz)
steel	**Mode 1**	311.21	17552
	Mode 2	423.31	18436
	Mode 3	360.92	20474
	Mode 4	328.92	22657
	Mode 5	247.13	25485
Aluminum alloy	**Mode 1**	523.41	17738
	Mode 2	725.19	18658
	Mode 3	609.74	20586
	Mode 4	556.03	22583
	Mode 5	416.49	25348
Cast iron	**Mode 1**	325.21	13534
	Mode 2	437.07	14198
	Mode 3	375.56	15842
	Mode 4	342.6	17625
	Mode 5	257.86	19850

VI. CONCLUSION

In this thesis, to turn the rear wheels out of phase to the front wheels. In order to achieve this, a mechanism which consists of two bevel gears and intermediate shaft which transmit 100% torque as well turns rear wheels in out of phase was developed.

The materials used for these analyses are Aluminum alloy, steel, and cast iron materials. Static analysis to determine the deformation, stress of the steering system at different rotational velocities (220,250,300&400rad/s), modal analysis to determine the natural frequency and deformation for 5 mode shapes. 3D modeled by using the

software Pro-Engineer and analysis done in ANSYS software.

By observing the static analysis, the stress values are increases by increasing the rotational velocity. Less stress values for aluminum alloy compare with steel and cast iron. By observing the modal analysis the deformation values more for aluminum alloy. So it can be concluded the aluminum alloy material is better material for steering mechanism system.

VII. REFERENCES

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