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# Modelling Of Intermediate Steering Shaft of Fiesta Car and Its Static Structural Analysis

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## ABSTRACT
The intermediate steering shaft is very important part in the steering system. The steering system is a group of parts that transmit the movement of the steering wheel to the front and sometimes the rear wheels. The steering system of car is not only important for safety reasons but also to enhance the comfort of car's ride. 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 and may also be part of the collapsible steering column design to allow it to deviate somewhat from a straight line.

In this project modelling of steering shaft is done by using Creo software and for the analysis ansys software is used. From the literature survey it is found that tremendous work is done on the steering system and its optimization but rarely work is done on the intermediate steering shaft or work on it is worth pursuing. So, I have taken this intermediate steering shaft as my M.Tech Project for the development in design or its optimization.

## Keywords
Intermediate: steering shaft: modelling: analysis and optimization.

## 1. INTRODUCTION
Automobile Steering system is composed of the following: A steering shaft included in the steering column connected to steering wheel, An intermediate shaft for connecting the shaft and the steering gear and steering gear for operating wheels. Intermediate steering shaft connects the steering shaft to the steering pinion. This components cannot be arranged on the same axis due to certain limitations in vehicle design. Drivers can change the direction of vehicles by operating steering wheel of the steering system. Steering system is important for steering feeling related to reaction force and is important apparatus having an influence on steering feeling.Torsional rigidity of intermediate steering shaft influences the steering feeling in accordance with the improvement in the automobile performance so it is necessary to improve the performance of the intermediate steering shaft. The objective of this project is to design a intermediate steering shaft which has greater working capabilities as existing one by saving the material and to find out vibration effects and behavior of intermediate steering shaft at harmonic frequencies in an automotive steering system. This objective is worth pursuing because the issue of stresses developed in an object, design requirements at the joints, deformation in body due to vibrations, continuous twisting and loading these are the common one related to intermediate steering shaft and is a real problem in the modern automotive industry.

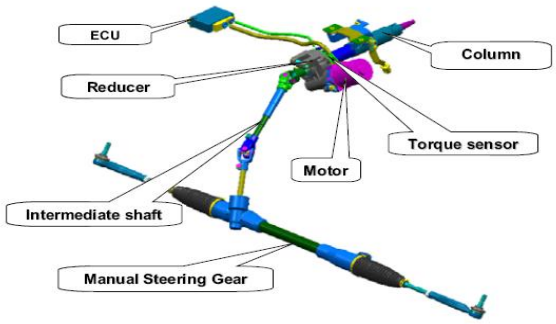


**Fig.1.Steering System**

## 2. LITERATURE REVIEW
**1.** Tae Rinse Winse Dhanesh Chatta and Ashish Nair Dept. of Mechanical Engineering, Govt. College of Engineering Kannur, Kannur, Kerala. Design of Pneumatic Collapsible Steering (IJTARME) Volume-2, Issue-2, 2013. In this Paper pneumatic collapsible steering column study is done which consist of single long collapsible steel rod which connects steering wheel to the steering box. On considering the injury potential of steering wheel this project gives a new and more safer design for the steering wheel. The main advantages of pneumatic steering are that provides working space for proper functioning of air bag. Its maintenance cost is low since need only to replace air or gas in it. It was concluded that this will be helping hand to decrease the death rate due to frontal collision.

**2.** D.Toffin, G.Reymond, A.Kemney, J.Droulez "Influence of Steering Wheel Torque Feedback in a dynamic driving Simulator." From this paper the torque on the steering wheel is estimated that it has of 2.5 Nm sense by electronic force feedback configured system. A preliminary study on the role of torque feedback in the steering wheel was conducted on the Clio dynamic driving simulator at RENAULT.

An experiment comparing different torque feedback strategies was conducted to evaluate the potential of driving simulators in the study of future steer-by-wire system. The experimental approach investigated in this paper may contribute to identify critical steering force information, or to design variable steering force feedback systems adapted to the driving tasks such as maneuvering, curve driving, motorway driving, etc.. to improve driver comfort and safety.

**3.** Hertlin(11-10-2011)Document: RTE-PUB-EF Natural Frequency Measurement Production E-1205817.docx

"Measurement and Evaluation of the Natural Frequencies of Components and Assemblies in Manufacturing and in the Laboratory." Vibrations of the Steering Column of a Motor Vehicle While moving or standing still, the vibrations of the front axle are transferred to the steering system by the wheels in the first case and by the engine in the second. This idling RPM is generally set somewhat higher than is absolutely necessary, in order to avoid vibrations. It is a question of relatively low natural frequencies less than 50 Hz. In this paper the vibration on Human can sustain is 4-5 Hz.

**4.** S.K.Chandole, M.D.Shende, M.K.Bhavsar "Structural Analysis of Steering Yoke ofan Automobile for Withstanding Torsion/ Shear Loads" IJRET Volume: 03 Issue: 03 Mar-2014. This paper deals with study of a Yoke of the steering system It is a very important part to attain stability and steady movement of the vehicle. It consists of two yokes, one on each shaft, connected by a cross-shaped intermediate member spider. In this work design and finite element analysis of steering yoke in automobiles is carried out. From the analysis performed the cold forged yoke can be sufficiently changed to stamped yoke depending on the torque loading conditions.

Hence steering yoke is analyzed for the stress produced under torque loading conditions and no plasticity is found in the part.

**5.** CheeFai Tan in this paper presents an integrated steering system design for bus drivers' drowsy driving behavior change. Busses involved in accidents due to drowsy driving are increasing nowadays and those accidents involved a lot of people due to the number of passengers it carries. In order to decrease the rate of accidents for bus driver due to drowsy driving, an integrated steering system that can change their driving behavior is developed. The developed integrated steering system is then being validated through surveys conducted on drivers with valid driving license. The survey results have shown that the integrated steering system is a feasible system to the drivers. Then being validated through surveys conducted on drivers with valid driving license. The survey results have shown that the integrated steering system is a feasible system to the drivers. Here author have suggested new steering system which acts according to drivers drowsy driving behavior change.

Intermediate Steering shaft is one of the important parts while designing such an intelligent system.

**6.** Manik A. Patil, Prof. D.S.Chavan, Prof.M.V.Kavade , Umesh S. Ghorpade"FEA of Tie Rod of Steering System of Car" IJAIEMVolume 2, Issue 5, May 2013 Page no.222. This paper presents and focuses on some Finite Element (FE) analysis of a typical tie rod of a car will be carried out and natural frequency will be determined.

Tie rod has been continuously a concern which may lead to structural failure if the resulting vibration and stresses are severe and excessive. The main task in this study is to find the deformation and stresses induced in the Tie-rod and optimizing it for various material combinations.

The FEA analysis of Tie rod is carried out to check its natural frequency, maximum stress analysis and deformation. In this Modal analysis of Tie rod is done which gives natural frequencies sets and stress and deformation which is under the acceptable limit.

**7.** Bhushan Akhare and Sanjeev S. Chouhan "Performance and Value analysis of Power steering system" IJETAE Volume: 2 Issue: 08 August-2012. Here in this paper all those points are discuss that will help to understand the whole system and the efforts that can be increase the efficiency of the power steering system. The power steering system mainly contains a steering wheel that wheel is connected with the shaft this shaft is then connect with the electronics system this system works according to position and torque sensor activity, this output will used to turn the vehicle in a preferred direction using a dc motor.

Power steering made vehicle driver smooth and effective driving in this paper the part of automobile i.e. steering is consider and how it works in terms of performance and values.

**8.** B.Babu, M. Prabhu, P.Dharmaraj, R.Sampath "Stress Analysis On Steering Knuckle Of The Automobile Steering System" IJRET Volume: 03 Issue: 03 Mar-2014. This Paper is about the steering Knuckle which is modeled using CAD software and various parameters such as Nodal displacements, Stress distribution are completely analyzed and studied. The study shows that the areas where the stress concentration is maximum due to the applied load and the portions in order to avoid frequent failures to improve its reliability. And shows how the stress calculations and deformation calculations are done.

**9.** Dan Xiang, Jian-zhong Yuan, Wei Xu "Study on Fuzzy PID Algorithm for a New Active Front Steering System "JCET Vol.2 No.1 January 2012 PP.24-29. The development of modern vehicle steering system has experienced five stages the mechanical steering system, hydraulic steering system, electro hydraulic power steering, system electric power steering system and active steering system. So far as safety and steering feelings are concerned, active front steering is a main trend of the development of current steering system has been discussed in this paper.

Above literatures have discussed about steering systems. But there are much scope in design of steering shaft and its optimization.

## 3. PROBLEM DEFINITION

Steering From literature survey and other observations it is found that there is lot of scope for design of intermediate steering shaft. Twisting load and vibrations are the root causes for defects in intermediate steering shaft.

There are following types of causes which can create defects as follows:

**1.** Twisting Load leads to Steering column failure which will create huge problem about driver safety and control on vehicle. Therefore it is very necessary to avoid development of stress due to the loading and try to minimize it.

**2.** A vibration is also causes for stresses and deformation of steering shaft. Lesser the vibration, strength of intermediate steering shaft hence column will be more.

3. By performing bucking analysis we can calculates it's maximum buckling and then it will become easy to state about its safety during accidental condition.

## 4. MODELLING OF INTERMEDIATE STEERING SHAFT IN CREO

Creo is a feature-based, parametric solid modeling system with many extended design and manufacturing applications. As a comprehensive CAD/CAE/CAM system, covering many aspects of mechanical design, analysis and manufacturing. It represents the leading edge of CAD/CAE/CAM technology, We are using Creo Element software for modeling of intermediate steering shaft.Dimensions required to model intermediate steering shaft are obtained by Reverse Engineering Process. Intermediate Steering Shaft of Ford fiesta car is taken for modeling and analysis. Steel rule, Screw gauge, Micrometer, Vernier caliper etc. instruments are used for taking the dimensions from actual intermediate steering shaft. CAD model of intermediate steering shaft is prepared in such a way that it should exactly represent the actual intermediate steering shaft.

There are several modules are given with every CAD software and each one having their own working areas.

1. Sketcher Module. For 2D sketches which can be converted into 3D.

2. Part Module. For development and editing of 3D parts.

3. Assembly Module. For assembling two or more parts.

With the help of this modules the intermediate steering shaft has been modeled in creo software shown below.

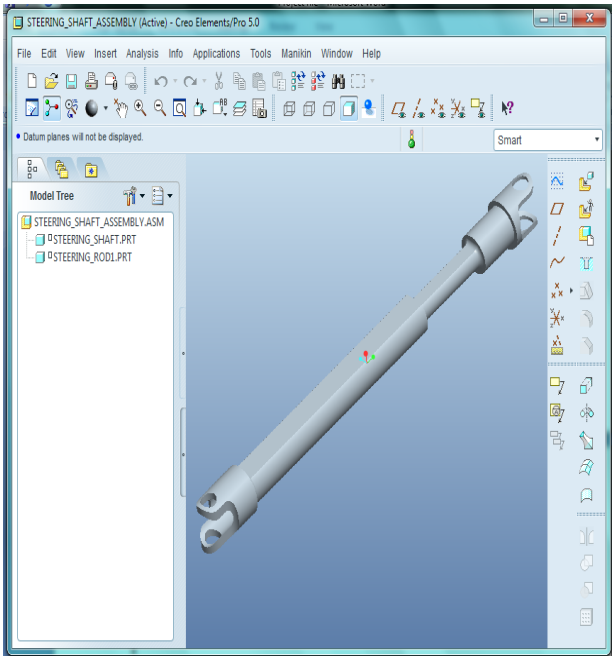


**Fig.2. Intermediate steering shaft in creo**

## 5. STRUCTURAL ANALYSIS OF EXISTING INTERMEDIATE STEERING SHAFT USING ANSYS

Structural analysis is probably the most common application of the finite element method. The term structural (or structure) implies not only civil engineering structures such as bridges and buildings, but also naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

Performance of structural analysis of intermediate steering shaft to find out effect of twisting load applied on shaft. After importing CAD file into FEA tool, set analysis type as a Structural analysis and type of element as 3D Tetrahedron element. Meshing of a intermediate steering shaft is done with 3D tetrahedron element.

Meshed view of intermediate steering shaft is given as bellow.

**Fig.3. Meshed view with loads applied**

By applying load and boundary conditions the maximum deformation can be calculated in intermediate steering shaft. Fig.4 shows the maximum deformation by applied twisted load.

**Maximum Deformation** = 0.01989mm.

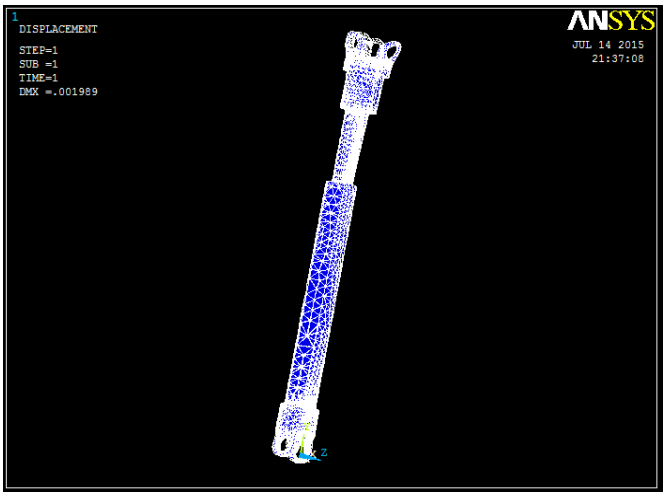


**Fig.4. Maximum deformation by applied twisted load**

**Shear Stress** in YZ direction =0.763608N/mm$^2$

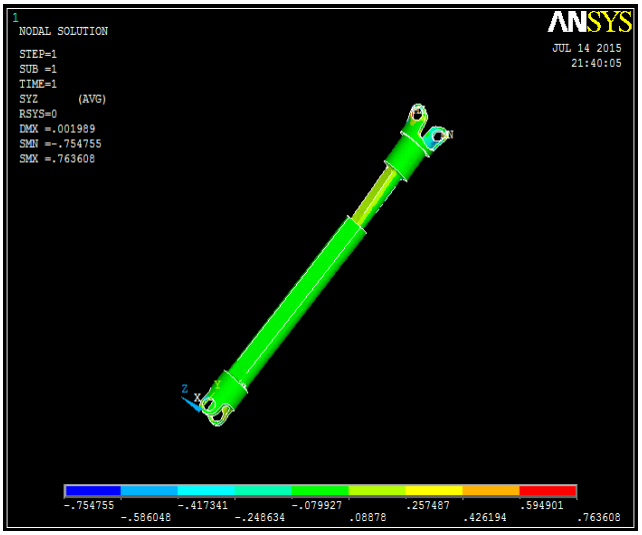


**Fig.5. YZ Shear stress**

**Von-mises Stress=**1.55333N/mm$^2$


**Fig.6. Von mises stresses in a intermediate steering shaft**

## 6. CONCLUSION

In this the intermediate steering shaft literature survey is made and it is found that there is lot of scope to improve the intermediate steering shaft and to improve its strength and rigidity by optimizing the design of the intermediate steering shaft by reducing the cost of the material and by saving the material.

## 7. FUTURE SCOPE

There is much scope in design of intermediate steering shaft to minimize its defect due to twisting, vibrations etc. Spring and Ball arrangement should be made at the connecting surface to optimize design this will provide better stability and less vibrational defects in intermediate steering shaft as well as column. For making the Shaft better the Shafts ends should be made thicker where the coupling is to be used at the and were the universal joint used at the end. The material properties at both the ends should be made different and instead of circular cut at the ends it any other shapes should be tried for more better results.

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