ANALYSIS OF UNIVERSAL COUPLING UNDER DIFFERENT TORQUE CONDITION

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Abstract

The power produced from an engine of automobile can be transferred to the drive wheel by power transmission system. Each automobile has different power transmission system constructive features depend on the vehicle's driveline concept.(H.Bayrakceken et al., 2006) To transmit the driving torque from the engine or gear unit to the wheels, most of passenger car and light vehicle driven by combustion engine has at least two driveshaft as a basic requirement (Amborn, P. 1995). During operation, torsional stress and bending stress was experienced by driveshaft due to the weight of the car or misalignment of journal bearing (Asi, 2006). In order to meet the requirements of one of the most highly stressed components in automotive assembly, a failure investigation must be conducted. Finite element method was used as stress analysis to determine the stress conditions at the failed section. Nearly all of driveshaft are metal shafts or metal tubes that has special joint at each end called universal joint (Birch and Rockwood2005).

Power transmission system of vehicles consist several components which sometimes encounter unfortunate failures. Some common reasons for the failures may be manufacturing and design faults, maintenance faults, raw material faults, material processing faults as well as the user originated faults. In this study, fracture analysis of a universal joint yoke and a drive shaft of an automobile power transmission system are carried out. Spectroscopic analyses, metallographic analyses and hardness measurements are carried out for each part. For the determination of stress conditions at the failed section, stress analysis is also carried out by the finite element method. The common failure types in automobiles and revealed that the failures in the transmission system elements cover 1/4 of all the automobile failures. Some common reasons for the failures may be manufacturing and design faults, maintenance faults, raw material faults as well as the user originated faults. This paper presents FEM analysis of universal coupling with the help of ANSYS for different torque or load condition and it verify by manual calculation.

Index Terms: *universal joint, power transmission system, drivechain, finite element analysis*

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1. INTRODUCTION

In day-to-day life every aspect is influenced by the work of engineer. The equipments we use, the food we eat, and the vehicles we travel in and many more all are developed with the assistance of design engineering. Traditional design has been done by simple calculation. But with increase in product performance and reliability it is difficult to follow the traditional iterative design procedures. As product performance becomes more important and as designs becomes more complex the simple method have becomes inadequate. To understand the growth and its implication for design, it is necessary to look at how design solutions are implemented. To satisfy the market needs it is necessary to provide a computational capacity along with the creativity of the human being. By adding computer technology to the armory of the designer, the best qualities of the designer can be linked with the best qualities of the computer. Most engineering designs are too complex for traditional approach. For example a structure may have spatially dependent material properties if different materials are used; the geometry may be irregular in some sense or the boundary condition may be complex. In all these examples no solution functions exist and so solutions can be achieved only by resorting to an approximate numerical method. A widely used numerical method for solving structural problems in both industry and academia is "FINITE ELEMENT METHOD".

2. UNIVERSAL JOINT

An automotive drivetrain is an assembly of one or more driveshaft, universal joint, and slip joint that forms the connection between the transmission and the drive axle. The function of drivetrain is that it allows the driver to control the power flow, speed and multiple the engine's torque.

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A universal joint (U-joint) is a joint in a rigid rod that permits the rod to move up and down while spinning in order to transmit power by changing the angle between the transmission output shaft and the driveshaft as shown in Figure1. The most common types of U-joint used in automotive industry is Hooke or Cardan joint (Birch and Rockwood, 2005). A basic U-joint consists of driving yoke, driven yoke, spider and trunnions. Each connection part of the spider and trunnion are assembled in needle bearing together with the two yokes. The driving yoke force the spider to rotate the other two trunnions. The previous action causes the driven yoke to rotate.

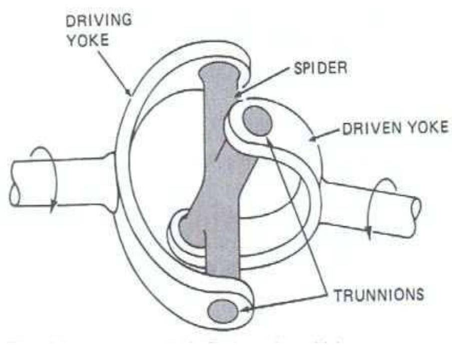

Fig- 1: Universal joint

A universal joint is used where two shafts are connected at an angle to transmit torque. In the transmission system of a motor vehicle, the transmission main shaft, propeller shaft and the differential pinion shaft are not in one line, and hence the connection between them is made by the universal coupling.

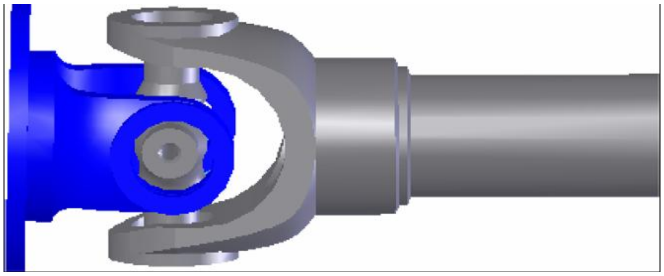

Fig- 2 Universal Joints

One universal joint is used to connect the transmission main shaft and the propeller shaft, other universal joint is used to connect the other end of the propeller shaft and the differential pinion shaft. A simple universal joint consists of two Y shaped yokes, one on the driving shaft and other on the driven shaft and the cross piece called the Spider.

There are two types of U-joints, the cross and roller type and the ball and trunnion type. The cross and roller type is used the most; it allows the drive shaft to bend. The ball and trunnion type less frequently used; it allows the drive shaft to bend and also permits backward and forward motion of the drive shaft.

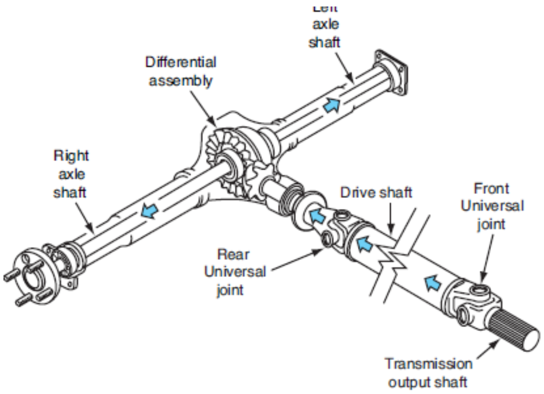

Fig.-3 Power flows from the transmission to the rear axle.

3. PROBLEM STATEMENT

Drive shafts are one of the most important components in vehicles. It generally subjected to torsional Stress and bending stress due to weights of components. Thus, these rotating components are susceptible to fatigue by the nature of their operation. Common sign of driveshaft failure is vibration or shudder during operation. Driveshaft mainly involves in steering operation of vehicle. Drivers will lose control of their vehicle if the drive shafts broke during high speed cornering. Because of this human life can be in great danger if we don't know when, where and how the drive shaft will failed. It is very important to know the accurate prediction for the drive shaft to fail.

4. FINITE ELEMENT ANALYSIS

The trend in engine industry today is toward a shorter product development cycle and faster time-to-market, with increased emphasis on up-front analysis to design, develop, and optimize a reliable and durable product. Electronic prototyping, instead of hardware prototyping, in the initial design stage can substantially reduce development costs.

The trend in structural analysis today is to perform system analysis instead of component analysis. The advent of faster computers and robust FEA software allows Design engineers to build larger, more refined and complex models resulting in timely, cost-effective, accurate, and informative solutions to customer problems.

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Recently there is an increase of interest in the investigation of the combustion chamber analysis and on its structural and thermal aspects. The combustion chamber is the one of the most important component in the dynamic condition of the vehicle .A detailed analysis and significant research efforts have been devoted to the investigation of structured analysis of the combustion chamber. The effects of the variable parameter such as stress, strain and displacement are computed in the structural analysis. Under the varying load condition i.e. pressure the study of structural behavior of engine block. Using the combustion chamber and study its thermal analysis, the flow factor of the thermal emission of the two- stroke SI engine is taken into consideration. Optimization technique is adopted to alter the fin length for minimum thermal dissipation.

Types of Solution Methods

Two solution methods are available for solving structural problems.

- The h-method
- The p-method.

The h-method can be used for any type of analysis, but the p-method can be used only for linear structural static analyses. Depending on the problem to be solved, the h-method usually requires a finer mesh than the p-method. The p-method provides an excellent way to solve a problem to a desired level of accuracy while using a coarse mesh.

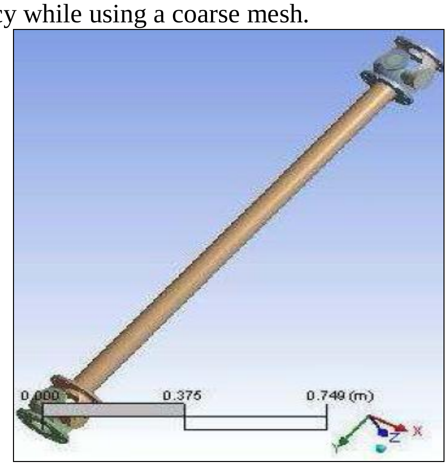

Fig.-4 Modeling of Universal Coupling

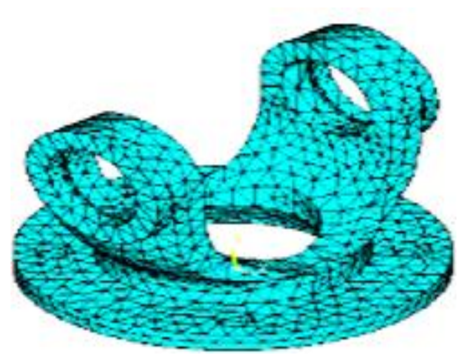

Fig.-5 Meshing View Nodes -15992 Element -7297

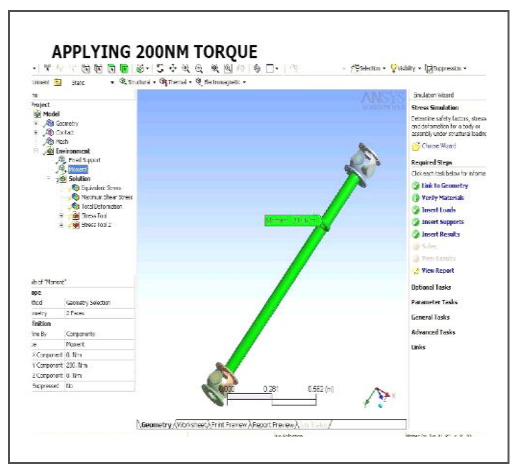

Fig.-6 Applying 200 Nm torque on universal coupling

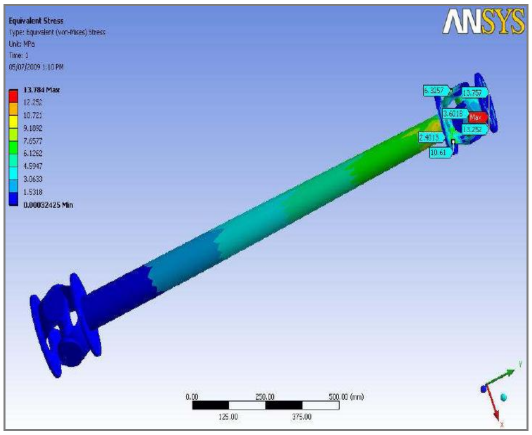

Fig.-7 Equivalent stress on Universal Coupling

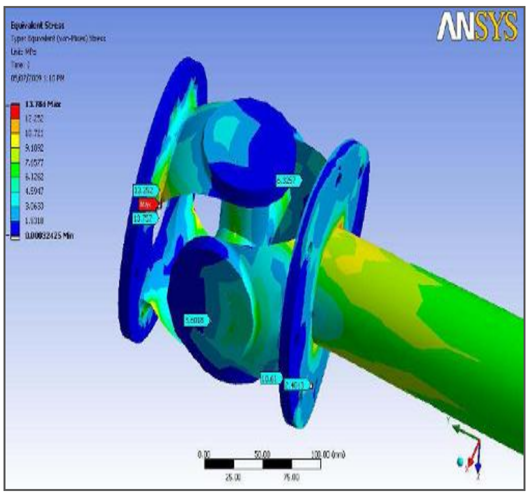

Fig.-8 Maximum Equivalent stress on Universal Coupling

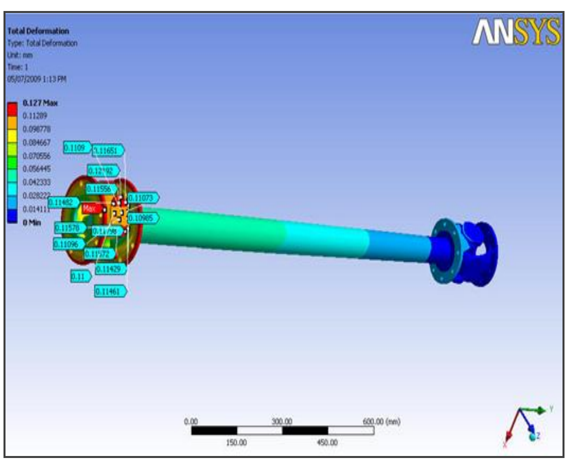

Fig.-9 Total deformation on Universal Coupling

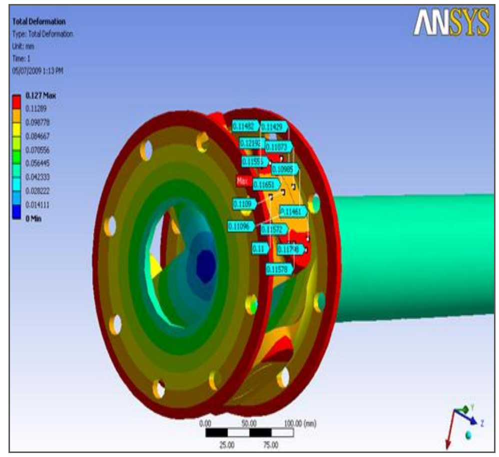

Fig.-10 Maximum deformation on Universal Coupling

5. RESULT COMPARISON ON DIFFERENT TORQUE (By ANSYS software)

At 200 NmTorque		
Result	Minimum	Maximum
Equivalent stress	0.00032Mpa	13.784 Mpa
Total Deformation	0	0.127 mm
At 150 Nm Torque		
Result	Minimum	Maximum
Equivalent stress	0.000287Mpa	12.2661 Mpa
Total Deformation	0	0.113 mm
At 100 NmTorque		
Result	Minimum	Maximum
Equivalent stress	0.000174Mpa	9.748 Mpa
Total Deformation	0	0.91 mm

Fig.-11 Equivalent stress on particular flange

Solved by manual calculation the result becomes as follows

	Software result	2 D CST result (Manual)	Axisymetric result (Manual)
Stresses	Min. 0.3289Mpa Max. 6.41 Mpa	σ1= (3.981, 2.28, 1.460) σ2= (-1.394, -0.41, 6.412)	(2.2594, -0.4693, 0.728, 0.6986) (4.2296, -1.51315, 2.135, -0.81)
Total deformation	Min . 0.11 mm Max. 0.12192 mm	(-9.39*10^-9, 8.23*10^-10, 0, 0, 2.26*10^-9, 3.43*10^-8) (0, 0, -2.26*10^-9, 3.43*10^-8, 0, 0)	(2.57*10^-10, 0, 3.89*10^-10, 0, 0, 0) (3.84*10^-10, 0, 0, 0, 0, 0)

6. CONCLUSION

The results were obtained are quite favorable which was expected. This result focus the relationship between the manufacturing cost and joint angle performance measures of an automotive universal joint, The results illustrate that an increase in the drivable joint angle requires a corresponding increase in manufacturing cost. However, for both the flange and weld yoke, a substantial reduction in manufacturing cost may be realized by restricting the joint angle to less than 30°. that the manufacturing cost of the flange and weld yokes may be decreased by 4.5% and 4.0%, respectively, while simultaneously increasing the joint angle by 34° and 38°.

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BIOGRAPHIES

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