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A REVIEW ON UNIVERSAL COUPLING

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ABSTRACT

A coupling is a device used to connect two shafts together at their ends for transmitting power. A Universal coupling is a special type of coupling in which misalignment of shafts is allowed. Shafts are free to move in any direction to transmit torque or power from one shaft to another. It also provides for the connection of shafts of units that is manufactured separately such as a motor and generator and to provide for disconnection for repairs or alternations and to reduce the transmission of shock loads from one shaft to another. In this work, review of different research papers is conducted. In this work, analysis is studied based on fracture of universal coupling, the stresses on universal joint when they are used in power transmission, development of a universal coupling using advanced computer aided engineering software, studying the stress, displacement and strain in a universal coupling.

INTRODUCTION

Universal joints are defined as a mechanical device that can transmit torque and/or rotational motion from one shaft to another at fixed or varying angles of intersection of the shaft axes. They are categorized by their motion characteristics as a single joint, which can be non-uniform or uniform. A uniform or constant velocity (CV) universal joint assembly transmits motion with an angular velocity ratio of unity between input and output members. The device commonly referred to as a universal joint transmits motion with various ratios of instantaneous angular velocity between driving and driven members when operating at angles greater than 0° and only a single joint is used. The average angular velocity is unity. This type of universal joint is normally referred to as either a Cardan or Hooke universal joint. Placing two universal joints in tandem with proper phasing allows the velocity fluctuations of the first joint to be cancelled by the second joint, allowing for a constant output speed equal to the input speed.

Figure 1: Universal Joint

LITERATURE REVIEW

In 2016, M. V. S. Reddy, et al. [1] studied the analysis based on fracture of universal coupling (used for power transmission) which is done using an FEA software i.e. Ansys workbench. As the stresses at the failed sections would be high so stress analysis is also done using FEA software. As most of the failures of an automobile is in the transmission system. This failures needs to be analysed. The objective is to determine the stress and displacement and optimized the existing universal joint. The results of the universal joint were obtained using the software with different materials like stainless steel, child cast iron and gray cast iron. It is observed that the gray cast iron is having less stress and displacement as compare to stainless steel and child cast iron and well within the permissible limit. Hence, from modal and structural analysis gray cast iron is the most preferable one. From this work, it concluded that there is an improvement in design parameter which leads to reduction in weight and cost.

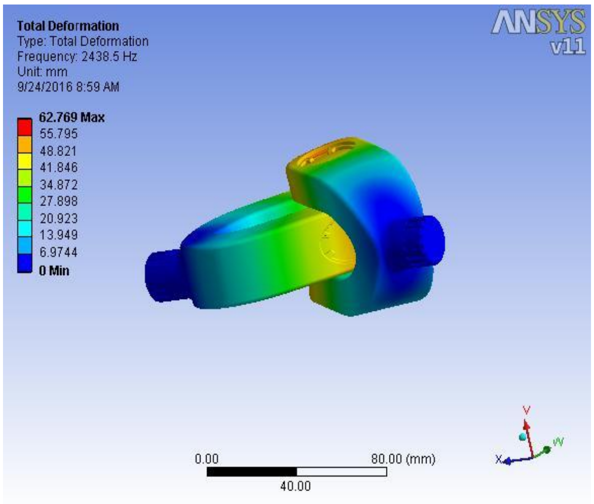

Figure 2: Model-1

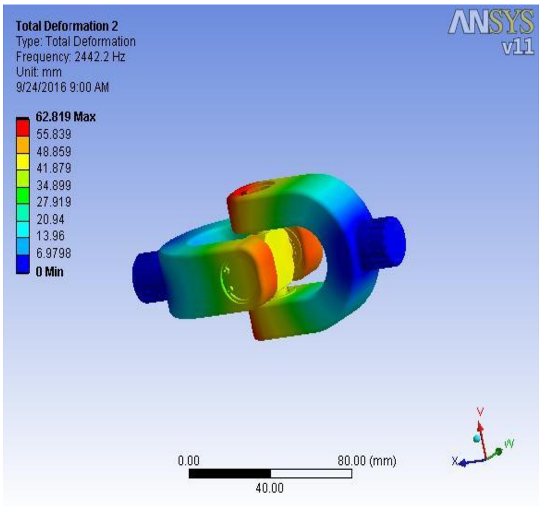

Figure 3: Model-2

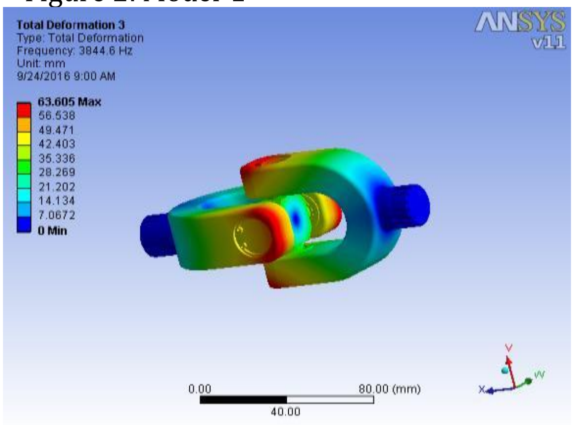

Figure 4: Model-3

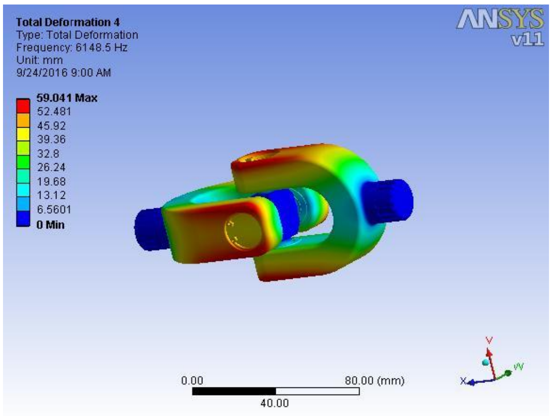

Figure 5: Model-4

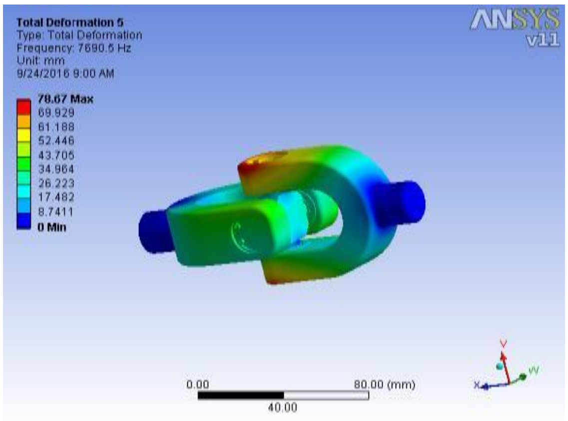

Figure 6: Model-5

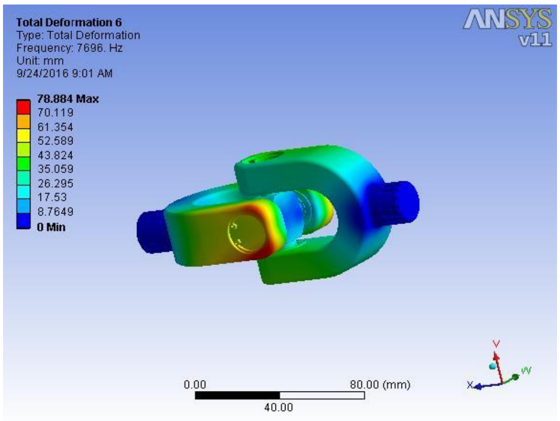

Figure 7: Model-6

Material	Structural Steel	Gray Cast Iron	CSI	Cast Iron
Model-1	60.71	62.76	62.62	60.93
Model-2	60.76	62.81	62.67	60.99
Model-3	62.02	63.60	63.47	62.08
Model-4	56.89	59.04	58.52	57.05
Model-5	76.20	78.67	78.41	77.30
Model-6	76.41	78.88	78.62	77.54

In 2016, G. Ramesh, et al. [2] studied the stresses on universal joint when they are used in power transmission. Main objectives are to reduce shear failures by Modification of pin (cross) in existing design of universal coupling. The modelling of proposed design is to be done by using CREO software & static and dynamic analysis is to be done in ANSYS software & results are compared with existing design. During operation, torsional stress and bending stress was experienced by driveshaft due to the weight of the car or misalignment of journal bearing. 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. Spectroscopic analyses, metallographic analyses and hardness measurements are carried out for each part. In existing design von mises stress and shear stress are 704.71 MPa & 351.3 MPa respectively. After the modification in pin`s design von mises stress and shear stress are reduced to 241.46 MPa & 120.04 MPa respectively. By the comparison of both the result it is found that the von mises stress is reduced from 704.71MPa to 241.46MPa & shear stress is reduced from 351.3MPa to 120.04MPa. So, shear failure is automatically reduced. 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°.

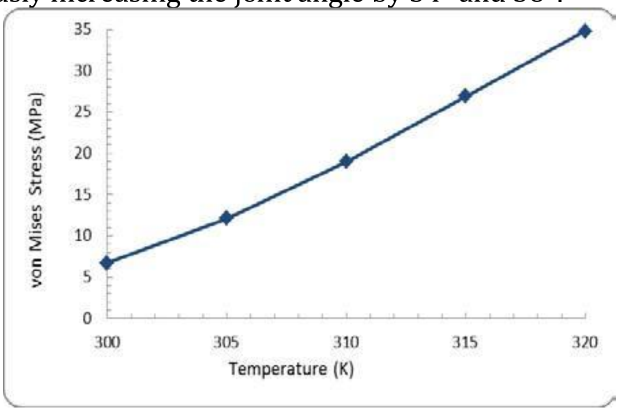

Figure 8: Stress - Temperature relation (load constant)

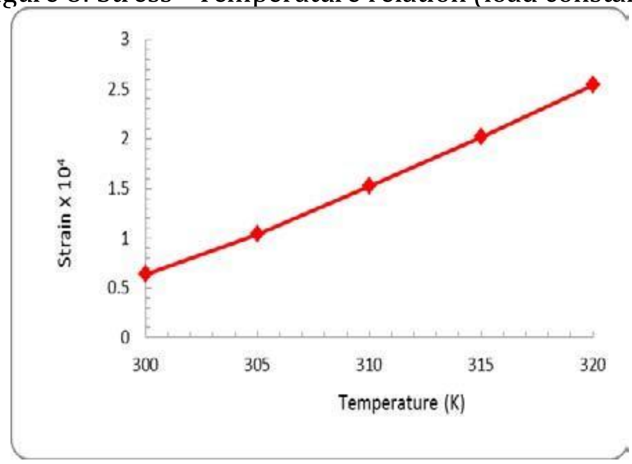

Figure 9: Strain-Temperature relation (load constant)

In 2016, A. Mandal, et al. [3] developed a universal coupling using advanced computer aided engineering software and study the various stresses and strains developed in the joint. The CAD model of the universal coupling has been designed using CATIA v5 by Dassault Systems. For the FEM, Ansys was used and meshing was completed. Static structural analysis is a finite element analysis used to simulate and ascertain the various loads, stresses, strains, deformations, etc. acting on a system. In this analysis the inertia and the effects of inertia is neglected. One end of the coupling is fixed while other end is subjected to a moment of 6400 N/m. From the results it is easily concluded that the fork pin experiences the maximum compressive stresses and strains as referenced earlier. The region where the fork and the fork pin makes contact experiences generally higher compressive stress and bending stresses. There is also stress concentration in the collar and pin due to the presence of notch. This leads to frequent wearing out of the pin which causes the shaft to wobble unnecessarily which reduces the mechanical efficiency of the transmission system. This leads to failure of the transmission system.

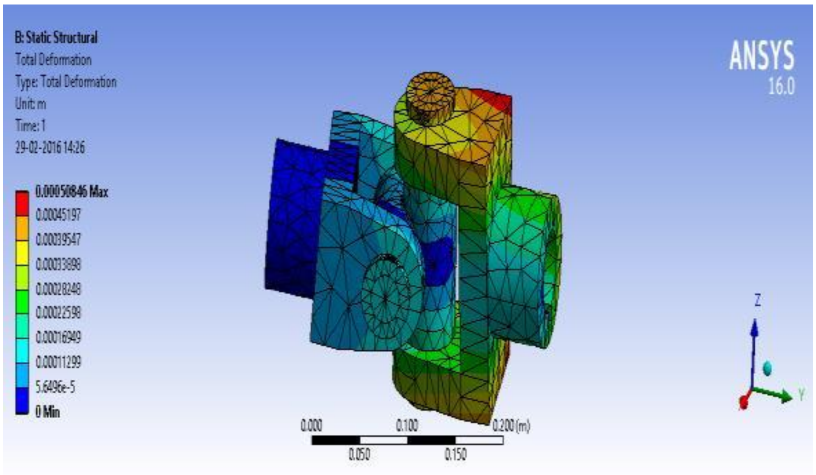

Figure 10: Total Deformation

In 2013, Md. Z. Rahman, et al. [4] studied the stress, displacement and strain in a universal coupling. Circumferential stress is applied at the yoke slot and also on the hub and simulated separately. The simulation is carried out with the help of SolidWorks 2010. To show the effect of temperature rise due to friction at the yoke slot, thermal load is gradually increased at the slot. In this paper, the material considered is Al1060 alloy. Modulus of elasticity of the material is E=69GPa and Poisson's ratio is v=0.33. The simulation has been carried out in room temperature, which is considered to be 25 0C. To find out the most critical condition in terms of stress and strain, the clearance between the hub and the slot of yoke is kept zero. In this generation of strain across the yoke is found to be maximum along the edge of the yoke extension. In this paper demonstration of displacement is shown which is found to be maximum at the free end of the yoke extension and also the demonstration of von mises stress is shown which is found to be maximum along the edge and at the extension-base intersection of the yoke. Relationship between temperature at the slot of the yoke and generation of maximum stress in the yoke, strain rate and temperature, temperature rise and displacement in the yoke has been showed. It is concluded that with the increase of temperature, as usual strain increases. The results are demonstrated both in the form of surface contour and graph. It has been showed that friction between yoke slot and hub can increase the temperature, which can eventually increase the thermal stress paving the way to failure of yoke or hub material. It is also found that the hub experiences a larger stress compared to the yoke when loaded under same pressure. Thus, the hub has the higher probability to fail than the yoke. At the end of the paper, some recommendations regarding universal coupling building material and reduction of friction have been made. Finally, the results obtained here are highly accurate and conform to the physical and loading conditions. Stress and strain generated in a universal coupling is discussed elaborately. Attention is mainly given to the yoke slot and the hub because they are the main frictional zones. Effect of thermal stress has also been demonstrated in case of the yoke. It is showed that friction can cause significant thermal effect which eventually can increase the stress intensity of the yoke.

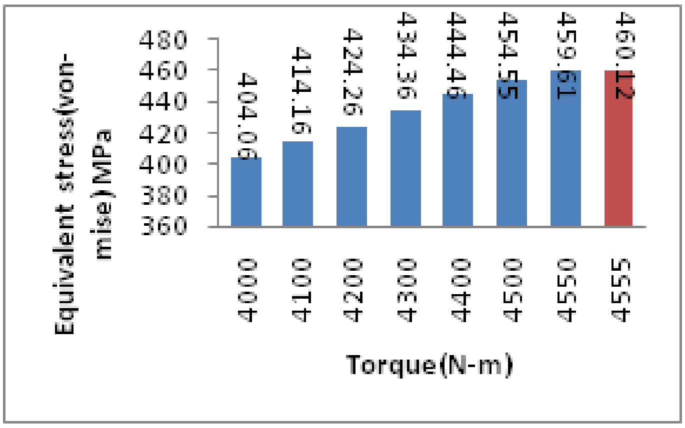

Figure 11: Equivalent stress in the universal joint at respective torque values

CONCLUSION

On the basis of the work, it is concluded that the design parameters of the universal coupling with modification give sufficient improvement in the existing results. Furthermore work is done in second paper on design & finite element analysis of universal coupling. By the comparison of both the result it is found that the von mises stress is reduced from 704.71MPa to 241.46MPa & shear stress is reduced from 351.3MPa to 120.04MPa. So shear failure is automatically reduced. In third review paper we can easily conclude that the fork pin experiences the maximum compressive stresses and strains. There is also stress concentration in the collar and pin due to the presence of notch leading to frequent wearing out of the pin which causes the shaft to wobble unnecessarily reducing the mechanical efficiency of the transmission system. This leads to failure of the transmission system. In fourth review paper effect of thermal stresses are demonstrated in case of the yoke. It is showed that friction can cause significant thermal effect which eventually can increase the stress intensity of the yoke.

REFERENCES

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