Analysis And Material Optimization Of Universal Joint By Using Composite Material

[1]Lokeshwaran.N, [2]Krishnakumar.P, [3]Vijayakumar.R, [4]Ashok.K, [5]Gnansekaran.M
[1]Assistant Professor, [2]UG Students, [3]UG Students, [4]UG Students, [5]Assistant Professor
Sri Balaji Chockalingam Engineering College, Arni-632317, Tamil Nadu

***Abstract* - A Hook's joint, also known as universal joint or universal coupling or carbon joint, is used for connecting two shafts whose axes are non-parallel but intersecting. It generally consists of two hinges located close together, oriented at 90 degree to each other, connected by a cross shaft. The material optimization of universal joint has superior strength, decrease in deformation, equivalent stress, weight & fuel consumption compared to structural steel. Thus in this paper the aim is to replace universal joint by composite material. The following material can be chosen are Aluminum Oxide composite, E-Glass composite. Analysis is being performed on universal joint.**

***keywords* - Universal joint, composite material.**

I. INTRODUCTION

The Hooke's universal joint comprises two yoke arm members, each pair of arms being positioned at right angles to the other and linked together by an intermediate cross-pin member known as the spider. When assembled, pairs of cross-pin legs are supported in needle roller caps mounted in each yoke arm, this then permits each yoke member to swing at right angles to the other. Because pairs of yoke arms from one member are situated in between arms of the other member, there will be four extreme positions for every revolution when the angular movement is taken entirely by only half of the joint. As a result, the spider cross-pins tilt back and forth between these extremes so that if the drive shaft speed is steady throughout every complete turn, the drive shaft will accelerate and decelerate twice during one revolution, the magnitude of speed variation becoming larger as the drive to drive shaft angularity is increased. Hooke's joint speed fluctuation may be better understood by considering.

The drive shaft horizontal and the driven shaft inclined downward. At zero degree movement the input yoke cross-pin axis is horizontal when the drive shaft and the output yoke cross-pin axis are vertical. In this position the output shaft is at a minimum. Conversely, when the input shaft has rotated a further 90°, the input and output yokes and cross-pins will be in the vertical and horizontal position respectively. This produces a maximum output shaft speed. A further quarter of a turn will move the joint to an identical position as the initial position so that the output speed will be again at a minimum. Thus it can be seen that the cycle of events repeat themselves every half revolution. The consequences of only having a single Hooke's universal joint in the transmission line can be appreciated if the universal joint is considered as the link between the rotating engine and the vehicle in motion, moving steadily on the road. Imagine the engine's revolving inertia masses rotating at some constant speed and the vehicle itself travelling along uniformly. Any cyclic speed variation caused by the angularity of the input and output shafts will produce a correspondingly periodic driving torque fluctuation. As a result of this torque variation, there will be a tendency to wind and unwind the drive in proportion to the working angle of the joint, thereby imposing severe stresses upon the transmission system. This has been found to produce uneven wear on the driving tyres. To eliminate torsional shaft cyclic peak stresses and wind-up, universal joints which rotate uniformly during each revolution become a necessity.

II. THEORY OF UNIVERSAL JOINT

The power transmission system is the system which causes movement of vehicles by transferring the torque produced by the engines to the wheels after some modifications. The transfer and modification system of vehicles is called as power transmission system. The power transmission system of vehicles consists of several components which encounter unfortunate failures. These failures may be attributed to material faults, material processing faults, manufacturing and design faults, etc. A major problem with the use of a Hooke's joint is that it transforms a constant input speed to a periodically fluctuating one. The kinematical consequences of this property of this joint can be remedied, as long as rigid body rotations are concerned, by using two converses Hooke's joint. But if torsional vibrations of the propeller shaft are concerned, there is no way of removing the dynamical consequences of an introduced Hooke's joint in a rear wheel drive vehicle. The schematic diagram of universal joint. In a widely used single piece drive shaft, two universal joints are used .Two universal joints are preferred in order to avoid the transformation of constant input speed into a fluctuating speed which is encountered when a single universal joint is used.

III. COMPOSITE MATERIAL

In Automotive, composites are being considered to make safer with low weight and more fuel-efficient vehicles. The fiber-reinforced composite is composed of a high strength fiber (i.e. carbon or glass) in a matrix material (polymer and metals i.e. Al, Mg etc.) and it can provide magnify properties compared with the individual materials by themselves. Many components like seat, roof, steering wheel, hatch, dashboard, mats, energy absorber, interior and exterior panel, wheels, leaf spring, engine cover etc. are fabricated by composite materials. For example, reducing a car mass by 100kg saves about 0.7litre fuel each 100km (directly and indirectly).Significant weight reductions with improved performance will mean less fuel consumption and CO2 emissions. The transport industries are customer sensitive and currently, the customers are pushing for the cost-effectiveness and the more environmentally friendly transport system. By using low cost, eco-friendly, and reliable materials the economic burden would be reduced for both the customer and the automotive industry. The demand for better fuel efficiency and reduced emissions developed the demand for weight reduction in order to comply with EU legislation (from <130g CO2/km in 2015 down to <95g CO2/km by 2021). Composites can offer lightweight benefits from 15-25% for glass-fiber reinforced composites (GFRP) to 25-40% for carbon-fiber reinforced composites (CFRP) in comparison to other structural metallic materials that are presently dominant, such as steel, iron, and aluminum.

IV. MATERIAL USED

The main motivators for the lightweight materials applications are weight savings and possible cost savings.

- Structural steel
- Aluminium oxide
- E-Glass

V. MATERIAL PROPERTIES

Table 1. Structural steel Material properties

S.NO	PROPERTIES	VALUES
1	Density (kg/m3)	7850
2	Young's modulus (MPa)	20000
3	Poisson's ratio	0.3
4	Bulk modulus (MPa)	16667
5	Shear modulus (MPa)	76923

Table 2. Aluminiuum oxide Material properties

S.NO	PROPERTIES	VALUES
1	Density (kg/m3)	3980
2	Young's modulus (MPa)	4130
3	Poisson's ratio	0.33
4	Bulk modulus (MPa)	40490
5	Shear modulus (MPa)	15526

Tablre 3. E-Glass Material properties

S.NO	PROPERTIES	VALUES
1	Density (kg/m3)	2600
2	Young's modulus (MPa)	73000
3	Poisson's ratio	0.22
4	Bulk modulus (MPa)	43452
5	Shear modulus (MPa)	29918

VI. MODELLING OF UNIVERSAL JOINT

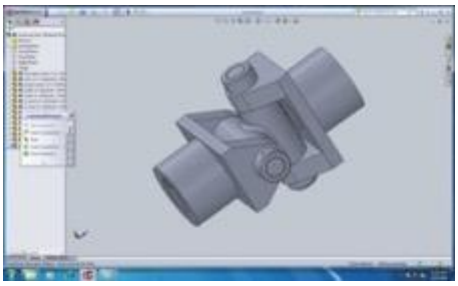

Figure 1. Modeling sketch of universal joint model

VII. ANALYSIS OF UNIVERSAL JOINT

Analysis of UNIVERSAL JOINT on ANASYS Software
Procedural steps followed in ANSYS WORKBENCH
Structural analysis:
In this step the model is imported into ANASYS workbench as follows:

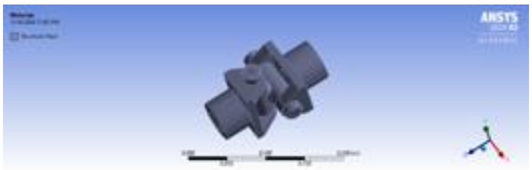

Figure 2: Imported model

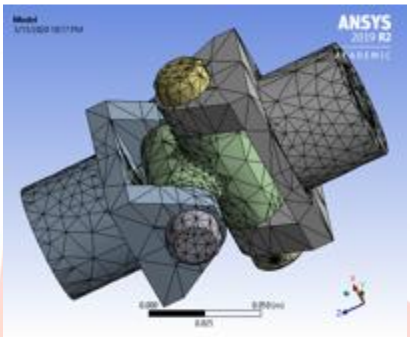

Figure 3: Universal Joint Meshing model

Structural steel details

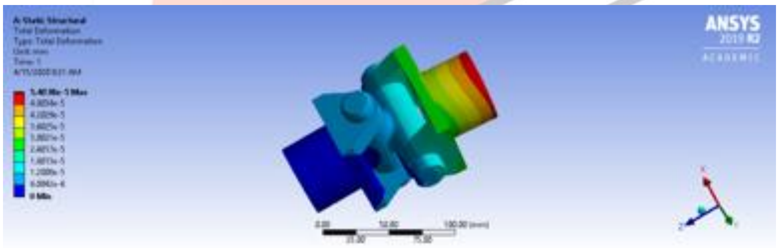

Figure 4: Total deformation

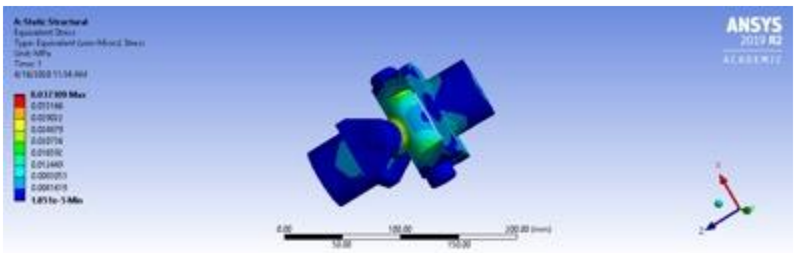

Figure 5: Von-mises stress

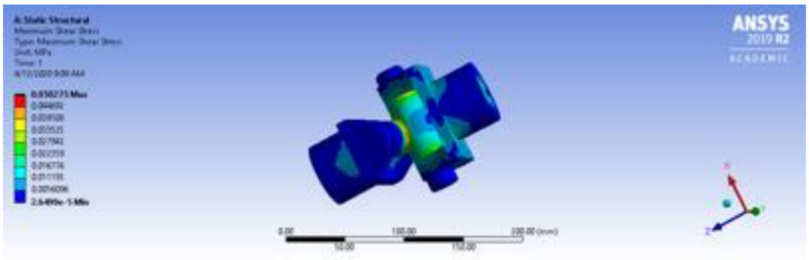

Figure 6: Maximum shear stress

Aluminium oxide details

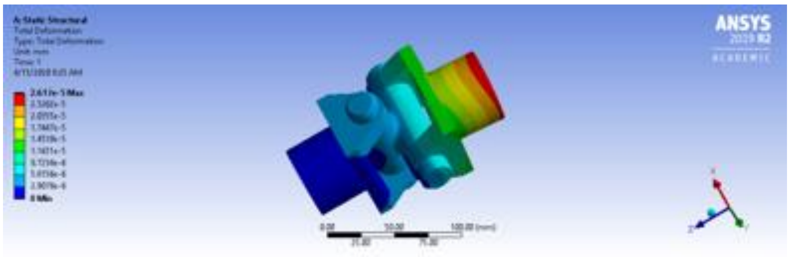

Figure 7: Total deformation

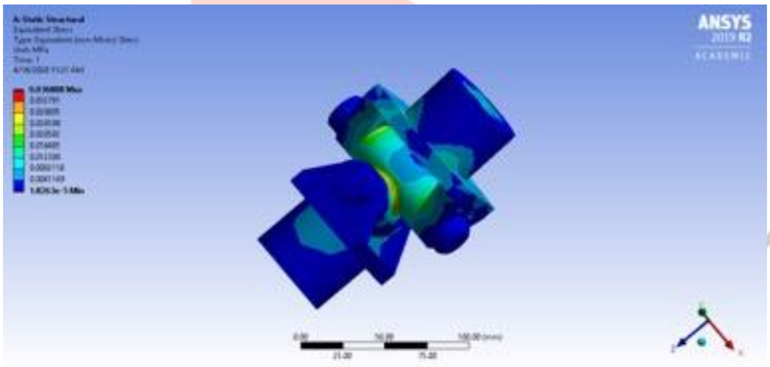

Figure 8: Von-mises stress

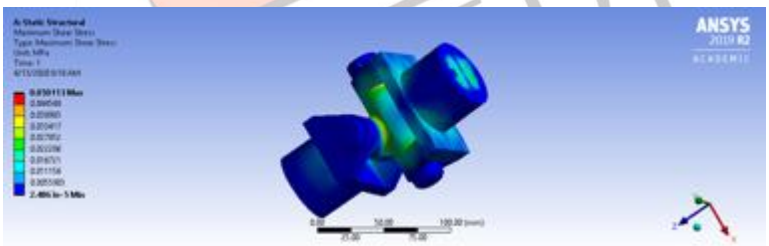

Figure 9: Maximum shear stress

E-glass details

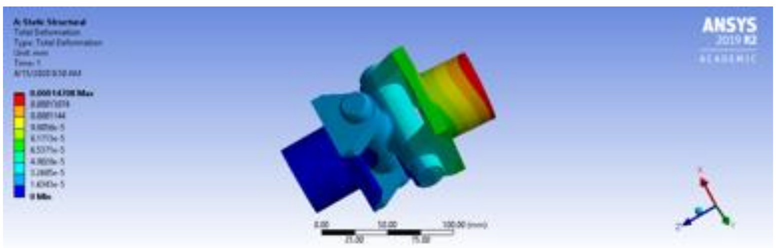

Figure 10: Total deformation

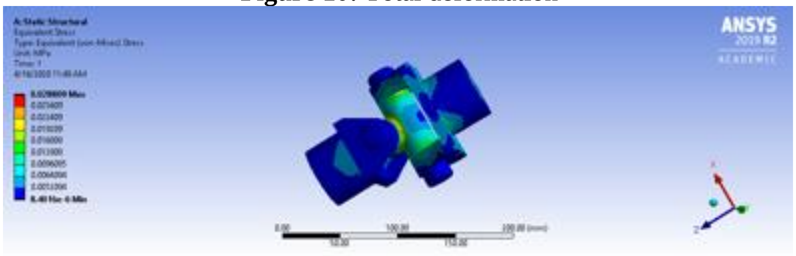

Figure 11: Von-mises stress

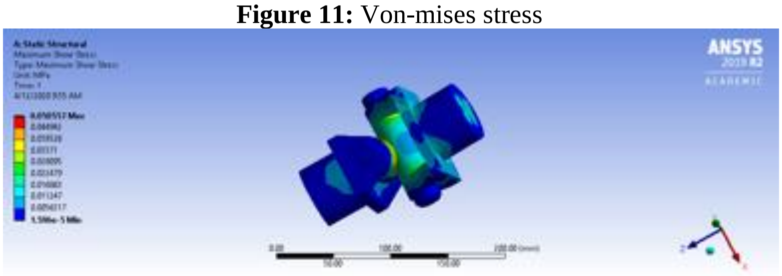

Figure 12: Maximum shear stress

VIII. RESULT

S.NO	Material	Weight,W(Kg)	Deformation,x(mm)	Von-mises stress(MPa)
1	Structural steel	3.572	0.000054037	0.037309
2	Aluminium oxide	1.811	0.00002617	0.036888
3	E-glass	1.183	0.00014708	0.028809

The universal joint is analyzed by the different material like structural steel, aluminium oxide, E-glass. From static structural and modal analysis, the material E-glass is preferable one, because the material e-glass is got less deformation as 0.00014708 mm and stress 0.028809 MPa from static structural analysis.

IX. SCOPE FOR FUTURE WORK

There is a more scope for further in universal joint simulation to solve torsional, and bending natural frequency have been improved by using this approach. The main purpose of this paper is to improve the existing design and weight reduction of universal joint with improving mechanical properties of the composite material. Using different material we will find out the weight reduction of existing material.

X. CONCLUSION

The use of composite material reduces the weight of joint significantly as composite having lower density. The reduction in weight gives further advantages in increase in fuel economy of vehicle. When we compare steel and E-Glass the weight reduction is 75% to 80%. On the basis of results it was observed that E-Glass universal joint has superior strength, decrease in deformation, equivalent stress, weight & fuel consumption compared to structural steel. Universal joint will be analyzing in the ANASYS and result will be compared. Therefore, E-Glass is most preferable for making universal joint.

XI. REFERANCES

[1] Material Optimization and Weight Reduction of Universal Joint Yoke Using Composite Material Ritesh P. Neve1, A.V.Patil 2 1(P G student, Department of Mechanical Engineering S S G B COE & T, Bhusawal, Maharashtra, India) 2(H O D Department of Mechanical Engineering S S G B COE & T, Bhusawal, Maharashtra, India)

[2] Lightweight Composite Materials for Automotive - A Review Murlidhar Patel1, Bhupendra Pardhi2, Sulabh Chopara3, Manoj Pal4 1,2,3,4Student, Department of Mechanical Engineering (Machine Design), Institute of Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India, 495009

[3] Design and Analysis of Universal Coupling Joint Maram Venkata Sunil Reddy1, C. Raghunatha Reddy2 M.Tech Student1, Assistant Professor & H.O.D2 Department of Mechanical Engineering Tadipatri Engineering College, India

[4] Structural Properties and Surface Characteristics on Aluminum Oxide Powders Takashi Shirai, Hideo Watanabe, Masayoshi Fuji and Minoru Takahashi Ceramics Research Laboratory, Nagoya Institute of Technology Hon-machi 3-101-1, Tajimi, Gifu 507-0033, JAPAN

[5] Design and Analysis of a Automobile Chassis by using Composit Material E-Glass Epoxy Prashanth. A 1, Dumpa Suresh 2, V. Sivaramakrishna3 Assistant Professor, Department of Mechanical Engineering, Malla Reddy Engineering College, Hyderabad, India1 Assistant Professor, Department of Mechanical Engineering, Malla Reddy Engineering College, Hyderabad, India2 Assistant Professor, Department of Mechanical Engineering, VNR Vignan Jyothi Engineering College, Hyderabad, India2