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STATIC STRUCTURAL ANALYSIS AND MATERIAL OPTIMIZATION OF UNIVERSAL JOINT YOKE USING ANSYS

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Abstract —*Universal joints are used to transmit power and torque from one shaft to another. In the present work static loading condition is considered for designing. For this CAD model of universal joint yoke is prepared in CATIA software and Finite Element Analysis is performed in ANSYS workbench and total deformation, stress and strain distribution is calculated. The material selected is aluminium silicon carbide composite due to light weight and good strength.*

Keywords*-Universal Yoke, CAD, CATIA, ANSYS.*

I. INTRODUCTION

Universal joints are defined as mechanical devices 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 nonuniform or uniform. A uniform or constant velocity 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 transmit motion with various ratios of instantaneous angular velocity between driving and driven members when operating at angles greater than 0^o 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 universa joint [3].

Each universal joint assembly consists of three major components: two yokes (flange and weld) and a cross trunnion. An automotive flange yoke has a machined flat face which may be affixed through a bolted connection to the rear differential of a vehicle. A weld yoke incorporates a machined step, and is inserted into the end of the driveshaft and welded in place. The cross trunnion is used to deliver rotation from one yoke to another using four needle pin bearings as shown in Figure 1 [2].

Figure 1 Universal Joint

II. MEDHODOLOGY

The first step is to prepare a CAD model of universal joint yoke. The model of universal joint yoke is designed in CATIA V5 software and saved in iges format. The model of yoke is then imported in Solidworks software and saved in Parasolid (x_t) format file for no data loss. This Parasolid file of yoke is then imported in ANSYS workbench. In the present work, material of universal joint yoke is replaced by aluminium silicon carbide Composite. The deformation and stress contours have find out using ANSYS workbench. The results obtained are compared with available results in literature survey. The Figure 5.1 shows the drawing of universal joint yoke.

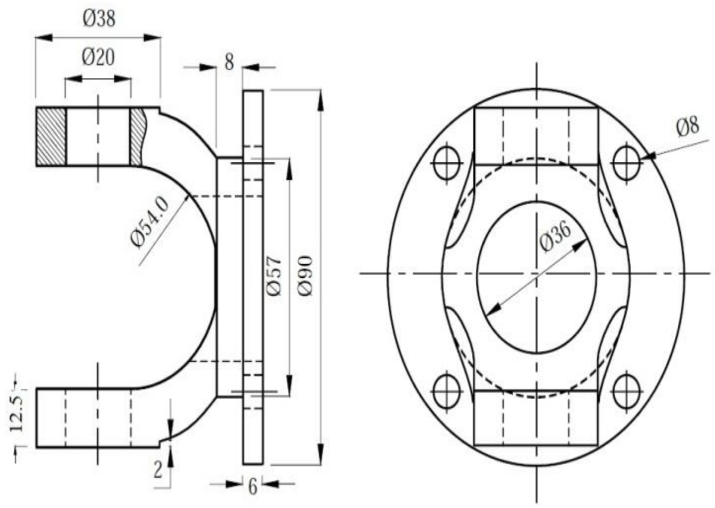

Figure 2 Universal Joint

The Figures 3 and Figure 4 show the CAD model of universal joint yoke in CATIA V5 Software and ANSYS workbench respectively.

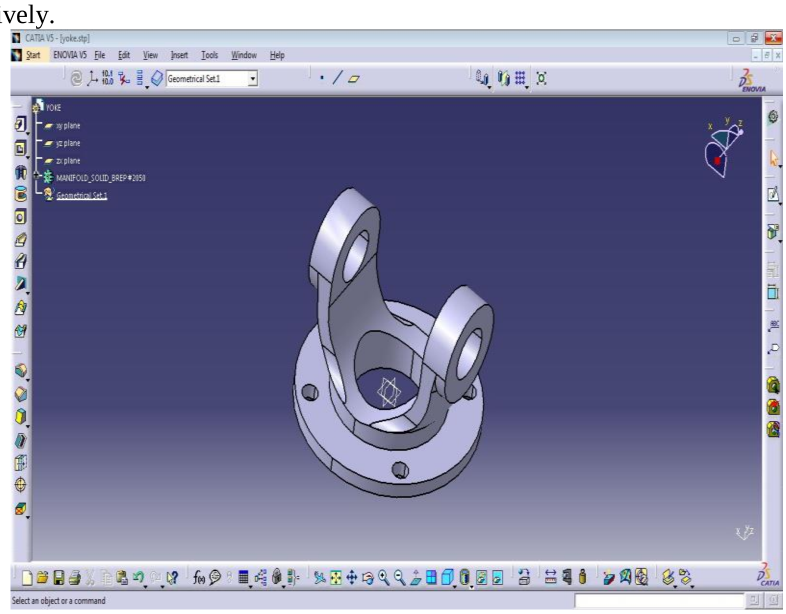

Figure 3 CAD Model of universal joint yoke in CATIA V5

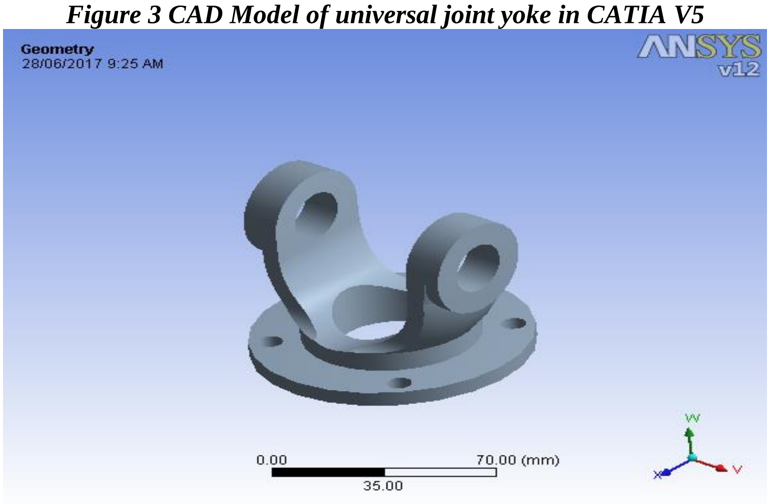

Figure 4 CAD Model of universal joint yoke in ANSYS workbench

The material used in this work is aluminium silicon carbide composite. Table 1 shows the mechanical property of aluminium silicon carbide composite [1].

Table 1 Mechanical Properties

Material	Aluminium Silicon Carbide
Density	2880 kg/m^3
Young's Modulus	115 GPa
Poisson's Ratio	0.27
Shear Modulus	318.9 MPa
Ultimate Tensile strength	680 MPa
Ultimate Yield strength	340 MPa

III. MESH GENERATION

Finite Element mesh is generated using parabolic tetrahedral elements. The Von-Mises stress is checked for convergence. An automatic method is used to generate the mesh in the present work. Figure 5 shows the meshed model of universal joint yoke in ANSYS workbench.

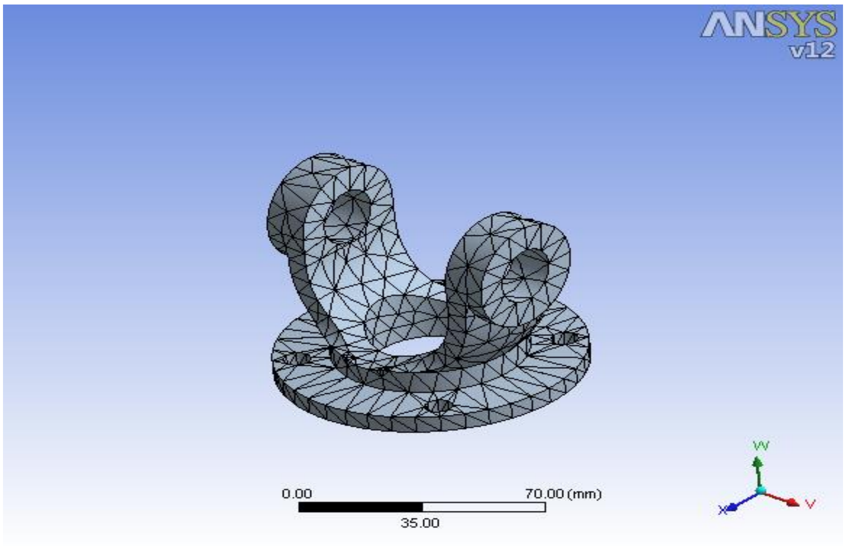

Figure 5 Meshed model of universal joint yoke in ANSYS workbench

IV. BOUNDARY CONDITION

After completion of the meshing, boundary condition and loads are applied. Boundary condition of the universal joint yoke involves the moment and fixed support. Loading conditions involves a moment of 200 Nm and cylindrical support as shown in Figure 6 [4].

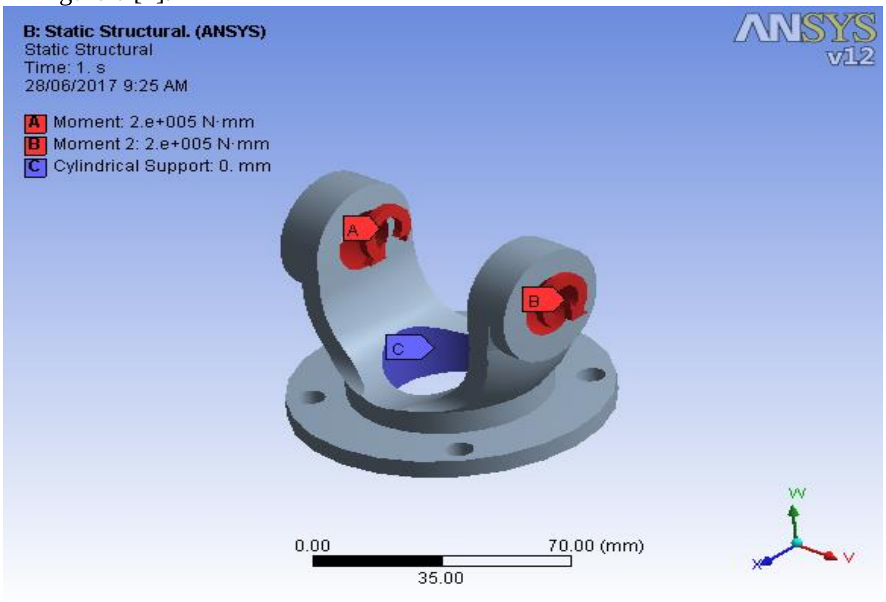

Figure 6 Boundary conditions

V. STATIC STRUCTURAL ANALYSIS

Static structural analysis is done in ANSYS workbench to find out the equivalent von-mises stress, total deformation and maximum shear stress. The maximum equivalent von-mises stress, total deformation, Equivalent elastic strain and shear stress is shown in Figures 7, Figure 8, Figure 9 and Figure 10 respectively.

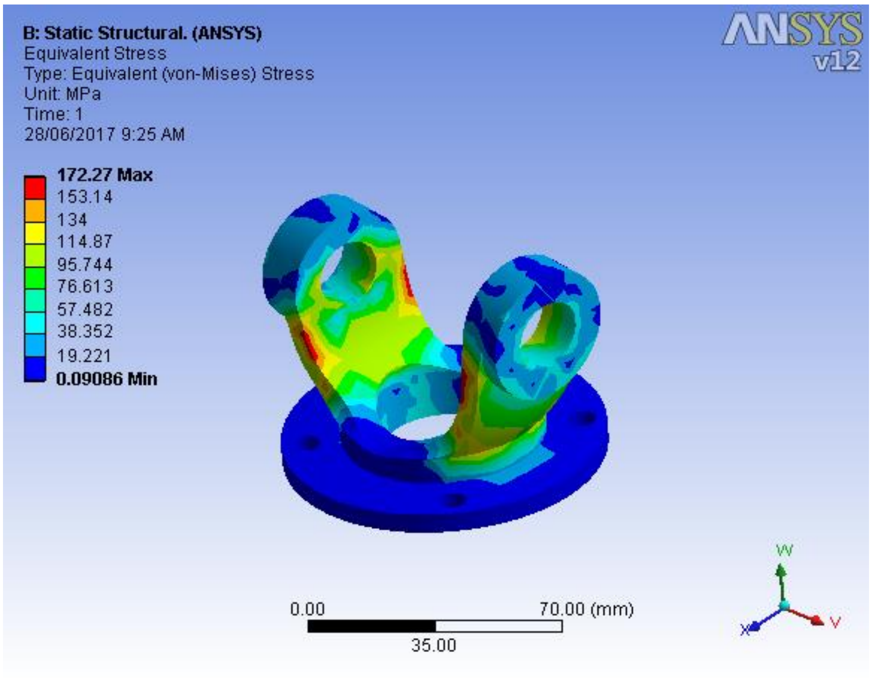

Figure 7 Equivalent von-mises stress

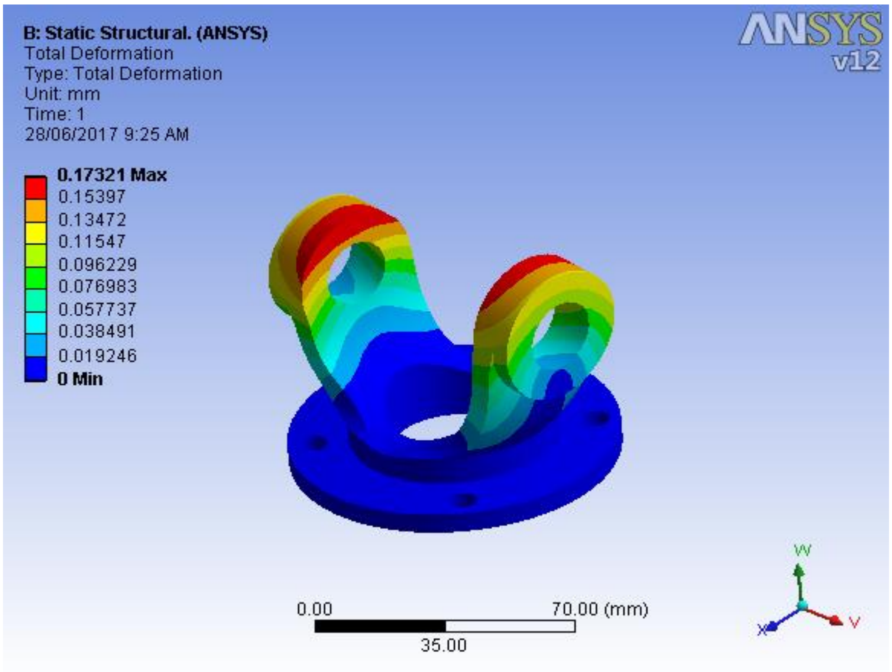

Figure 8 Total Deformation

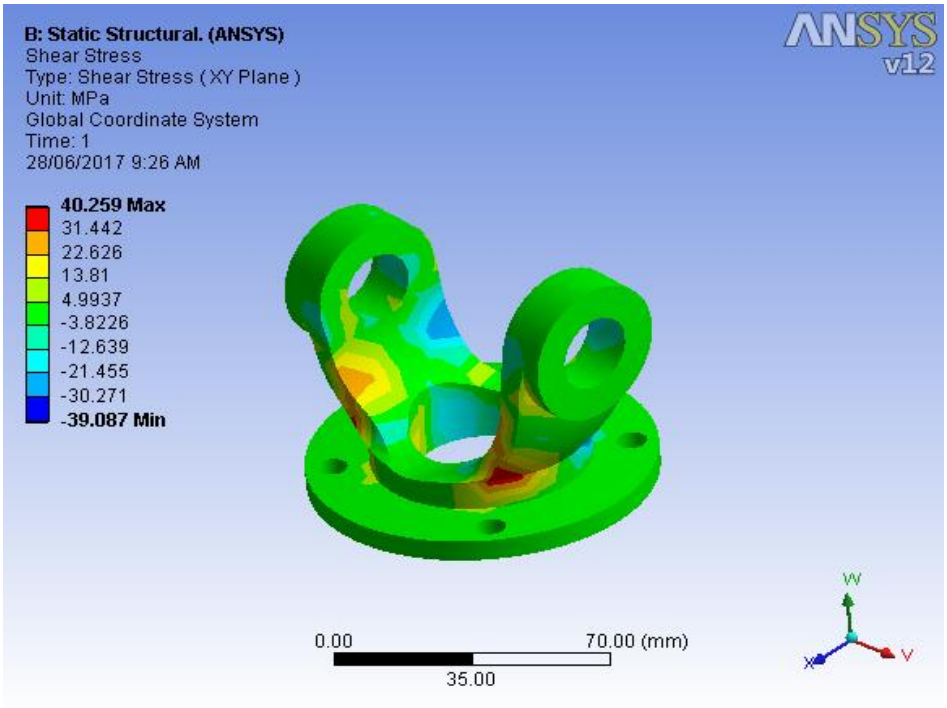

Figure 9 Shear stress

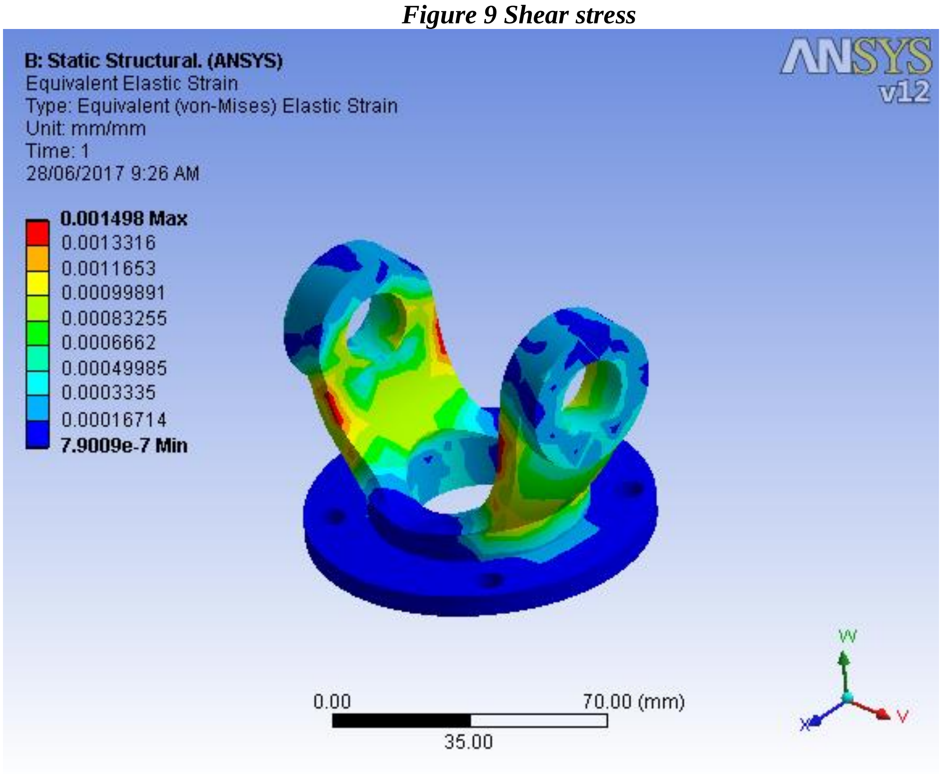

Figure 10 Equivalent elastic strain

The results obtained from the static structural analysis of universal joint yoke are shown in Table 2 and the results are compared with the existing results of paper.

Table 2 Result Comparisons of Static Structure Analysis

Sr. No.	Parameters	Existing Results	Modified Results
1.	Total Deformation in mm	0.10528	0.17321
2.	Equivalent (von-mises) stress in MPa	290.26	172.27
3.	Shear stress in MPa	79.028	40.259
4.	Equivalent elastic strain	0.0014513	0.001498
5.	Mass in kg	0.64315	0.2362

The FEA results are within the limit and are expectable. The values of total deformation, equivalent (von-mises) stress, equivalent elastic strain and shear stress are much below the yield limit and present design is safe. The weight of the universal joint yoke is reduced from 0.64315 kg to 0.2362 kg.

VI. CONCLUSION

The following conclusions are drawn from the present work of static structural analysis of universal joint yoke:

1. It can be seen from the Fig. 6.1 that the maximum von mises stress is 172.27 MPa which is less than the ultimate stress.
2. The maximum total deformation for the universal joint yoke is 0.17321 mm.
3. The shear stress found to be 40.259 MPa.
4. The mass of the universal joint yoke is reduced by 63.2% without compromising its strength and functionality.

On the basis of the current work, it is concluded that the design parameters of the universal joint yoke with material optimisation give sufficient improvement in the existing results.

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