Optimization and Modeling of Universal Joint

[1]Mayuri Pawar, [2]Vishal Patil, [3]Parth Gupta, [4]Om Panchal, [5]Rohit Patil, [6]Prof.R.K.Bhagat

[1,2,3,4,5]Students, [6]Professor
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Department of Mechanical Engineering
BRACT's Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India

***Abstract*: A universal joint is a junction or coupling that connects two spinning shafts that are parallel but not converging. It is also known as a universal coupling, a Cardan joint, a U joint, a Hardy-Spicer joint, or Hooke's joint. Motion, power, or both can be transmitted using a universal joint, a positive mechanical connection of all flexible couplings, the universal joint is one of the most ancient. It is primarily used on trucks and cars, as is common knowledge. Several industrial systems employ universal joints, which combine three materials: aluminium magnesium copper steel. It comprises of two hinges joined by a cross shaft that are near to one another and are aligned at 90 degrees to one another. Here, a universal coupling is redesigned in order to transmit power between two misaligned axes. Its strength to bear a given load is significantly greater than that of the present design. Engineers will be able to communicate thanks to innovative universal coupling designs, the motion of the driver shaft to the drive shaft at an axis that is not aligned (more than one axis). Using CATIA, a 3D modelling and analysis programme, and stress analysis, a universal joint was modelled and examined. The design of the Universal coupling is optimised using a finite element-based method. This Finite Element Method analysis of Universal coupling makes use of ANSYS software for the stress analysis and loading condition.**

***Keywords*: CATIA Software and ANSYS Software, Universal Joint**

INTRODUCTION

When the axes of two universal joints are inclined to one another by a certain angle, which may constantly change in a working environment, The ability to transmit torque from one shaft to another and rotate is a function of universal joints. In a vehicle's transmission system, universal joints serve three main purposes: (a) The longitudinally positioned rear drive axle and the front gearbox's propeller shaft end joints. (b) The sprung final drive and the unsprung stub axle for the rear wheels are connected by the rear axle drive shaft end joints. (c) Drive shaft end joints on the front axle's stub axle and the spring-loaded final drive that are located up front. In order to account for the angular movement of the swivel pin used to steer the front wheels as well as the vertical deflection of the suspension, these joints utilised for both the vertical and horizontal axes must be used to move the front outer drive shaft. Vehicles' power transmission systems are made up of a number of parts that occasionally experience tragic failures.

Common causes of failures include mistakes made during production and design, maintenance issues, problems with raw materials, problems with material processing, and user-initiated errors. This study examines fracture analysis of the drive shaft and universal joint yoke. Stress analysis using the finite element approach is also used to finding the stress conditions at the failed part. The most frequent auto failure categories showed that transmission system failures account for one-fourth of all auto failures. Manufacturing and design errors, maintenance mistakes, raw material mistakes, and user-initiated errors are some typical causes of failures.

There are several varieties of universal joints, including the Layrub and Doughtnut rubber coupling, as well as the Cross type joint, Hook type joint, and Crossed type with rubber bushing.

I. METHODOLOGY

Steps for the work:-

[1] Create the geometry of the yoke
[2] Mesh that geometry
[3] Provide the nature of the load and the loading values
[4] Solve the meshing model
[5] Determine the stressed areas Viewing the result
[6] Modify the Geometry/Model/Boundary condition
[7] Resolving the meshed model repeatedly
[8] Comparing the outcomes.

II. APPLICATION AND OBJECTIVE

Application- This universal joint is used in Truck .
Objective-
1) To do FEA analysis to replace the current universal coupling design.

2) Applying the chamfer feature to the coupling joint will increase the strength of the universal coupling.
3) To be able to lessen the amount of noise the universal coupling makes when rotating at high speeds.
4. To lower shear failure.

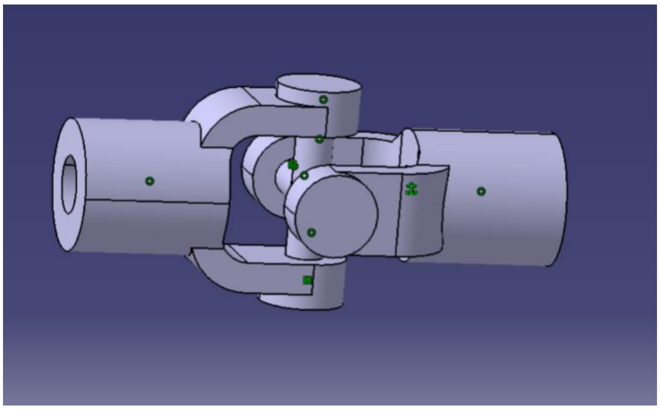

Fig. 2.1: Assembly of Existing Design

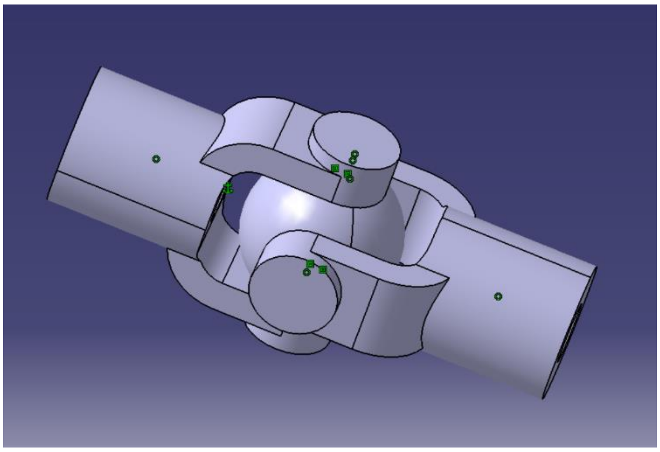

Fig.2.2: Assembly of New design

III. COMPARISON OF NEW DESIGN AND EXISTING DESIGN

1) The tension can be reduced in new designs due to an increase in the area of universal balls.
2) The whole assembly's length was increased from 176 mm to 326.64 mm to improve attachment to the spinning shaft.
3) The hub's design is the same in the current model.

The material "Structural Steel" is used to manufacture universal couplings.

Properties of structural Steel

Ultimate Tensile Strength	460	MPA
Modulus of Elasticity	220	GPA
Shear Modulus	76923	GPA
Yield Tensile Strength	250	MPA
Density	7850	Kg/m^3
Thermal conductivity	60.5	W/m-K

A) Design of Existing Model

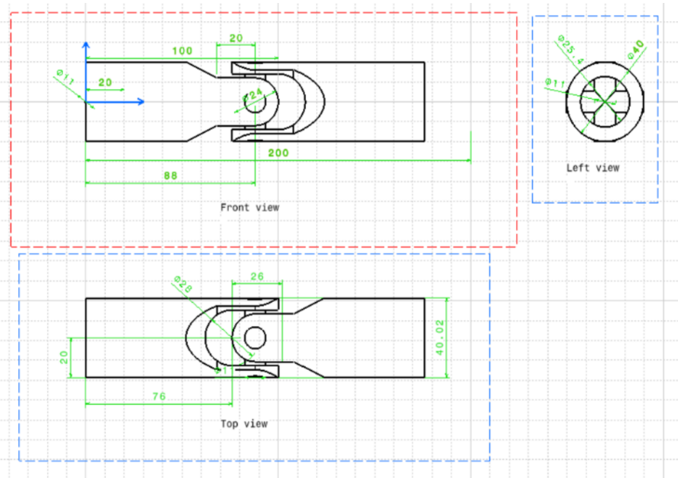

Fig. 3.1: Dimensions of Existing Design

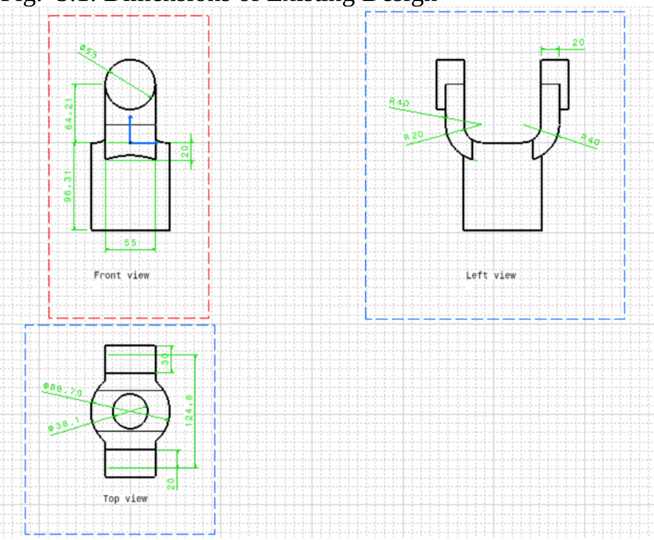

Fig. 3.2: Detailed Drawing of yoke

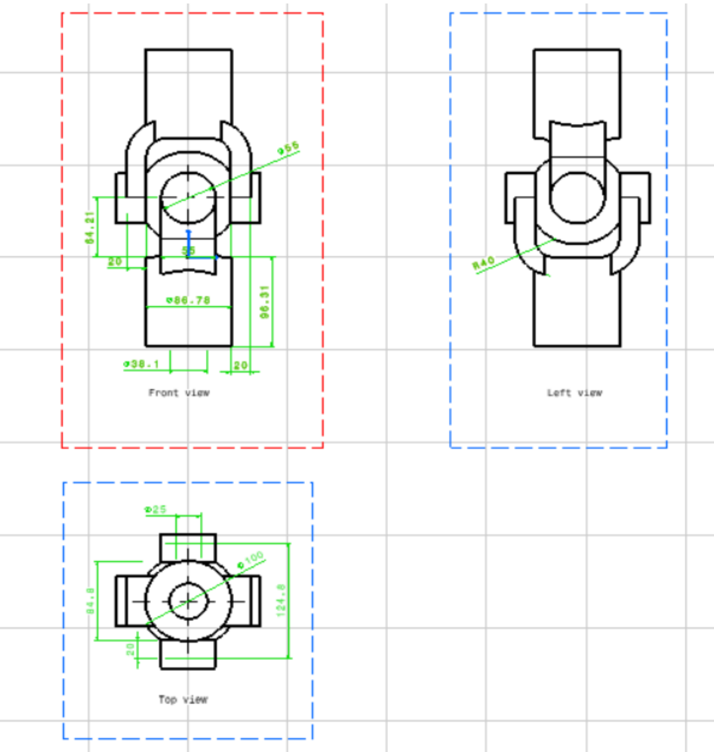

Fig.3.3: Dimensions of New assembly design

B) Modeling of Existing Drawing

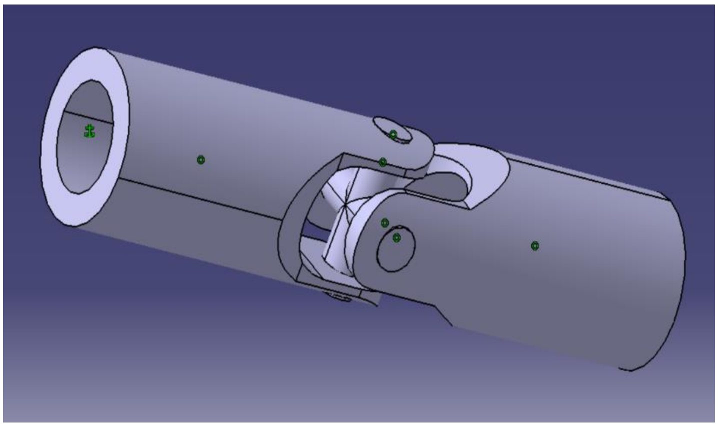

Fig.3.4 :Isometric Design of existing model

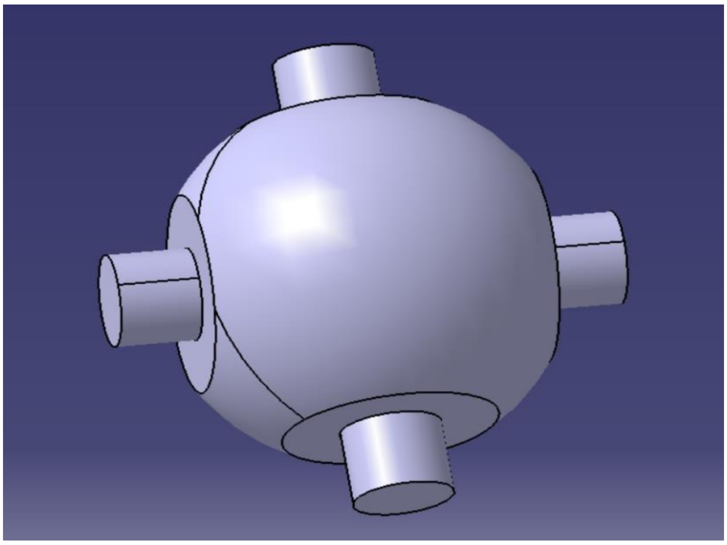

Fig.3.5: Isometric of New Ball

IV. FINITE ELEMENT ANALYSIS

Here, a design that complies with the dimensions restrictions of the theory of universal joints is put forth in order to prevent unwanted contact between the parts. Using ANSYS software, the stress analysis is carried out analytically and numerically using the finite element method. Moment is 5200N.mm and Force is 1990KPA in this instance.

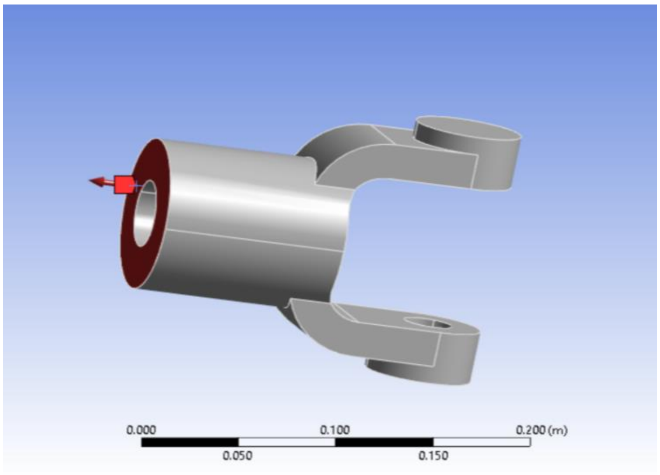

Fig.4.1.Loading of Hub

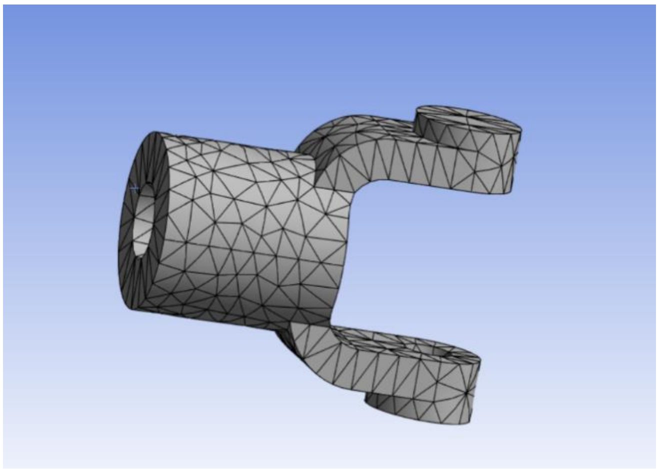

Fig.4.2. Meshing of Hub

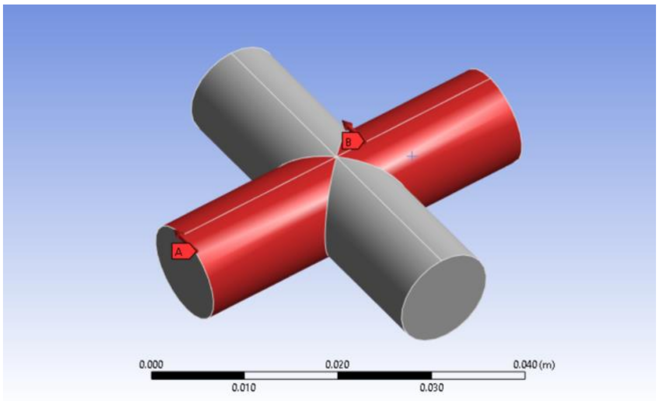

Fig.4.3.Loading of Pin

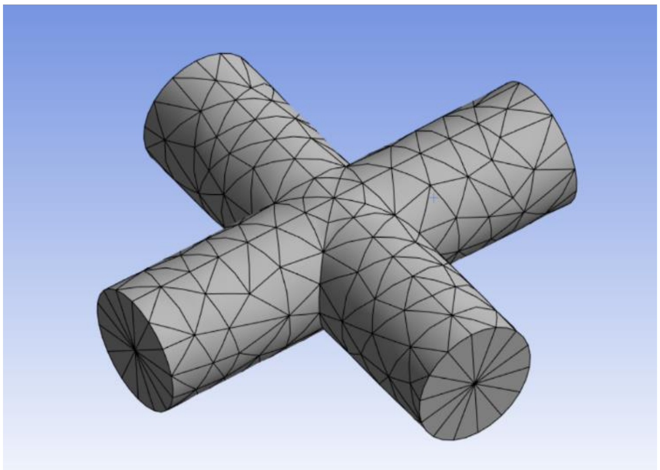

Fig.4.4.Meshing of Pin

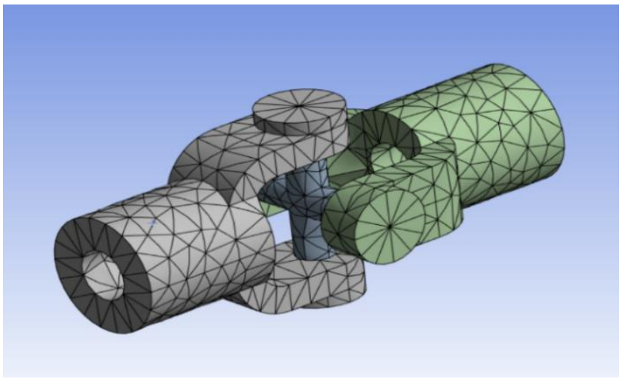

Fig.4.5. Meshing of Assembly

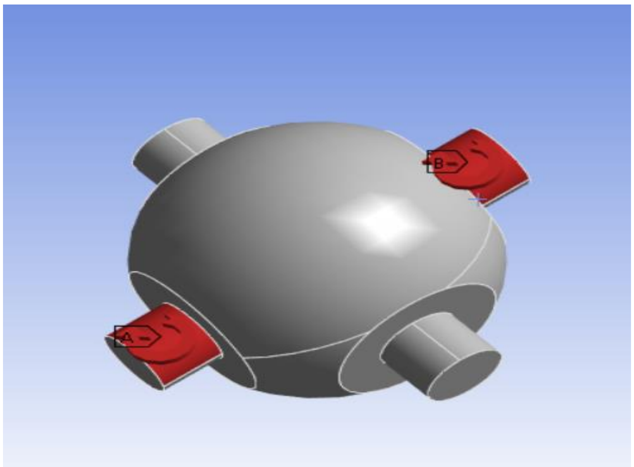

Fig.4.7:Loading of Pin for New drawing

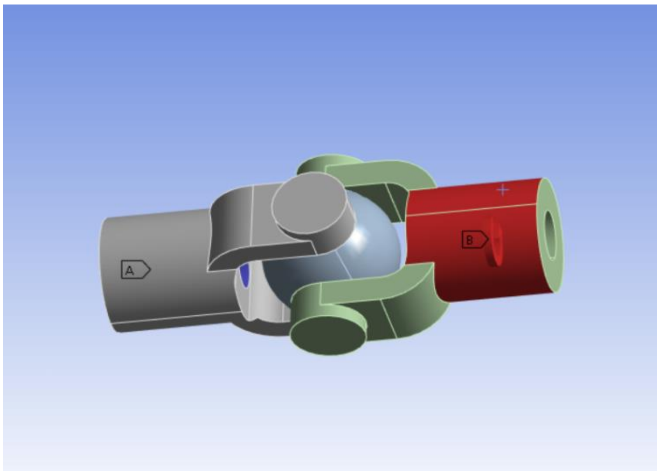

Fig.4.9: Loading of assembly of new drawing

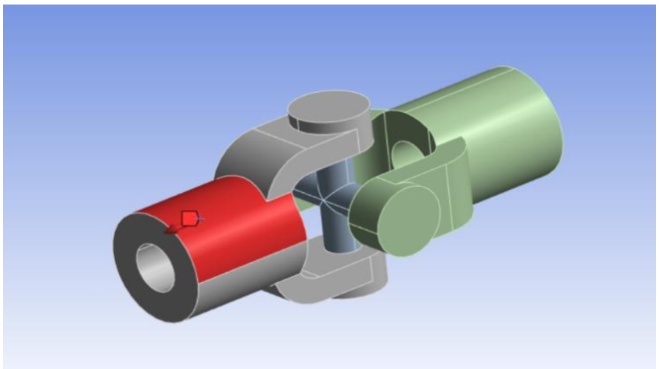

Fig.4.6. Loading of Assembly

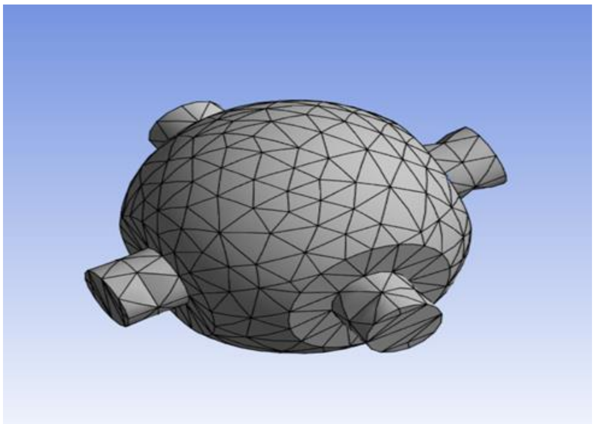

Fig.4.8: Meshing of Pin for New drawing

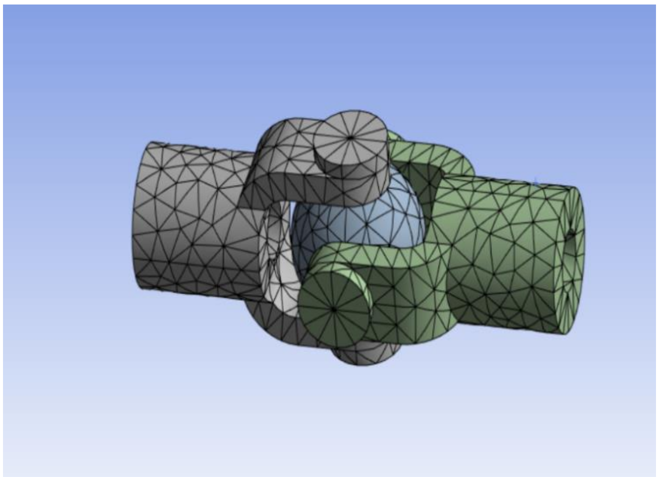

Fig.4.10: Meshing of assembly of new drawing

V. Analysis of Existing and New model of Universal Joint

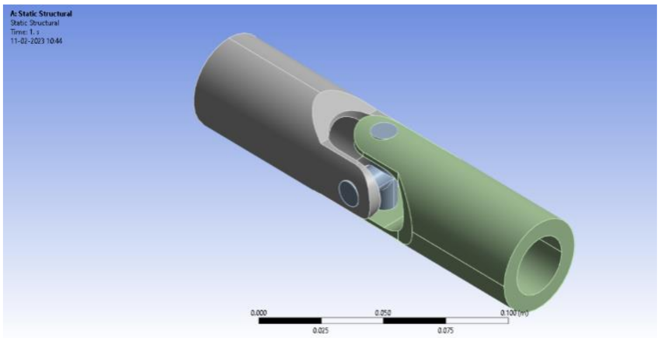

Fig.5.1: Modeling of existing Design

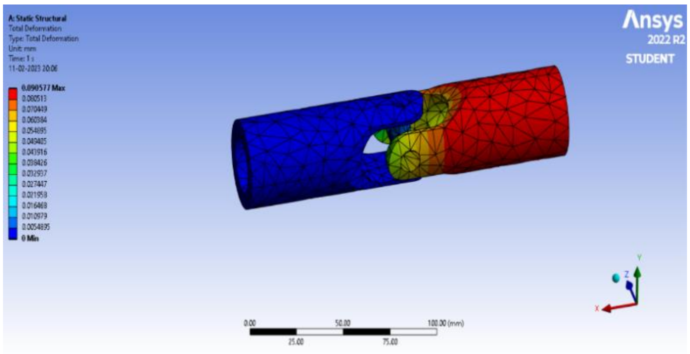

Fig.5.2:Total deformation of existing coupling

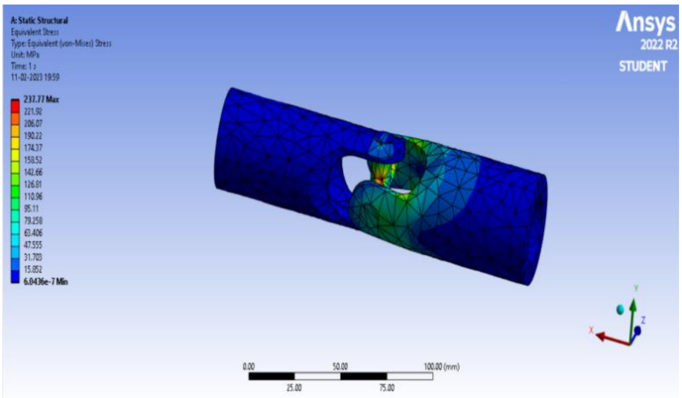

Fig.5.3: Stress Analysis of existing design

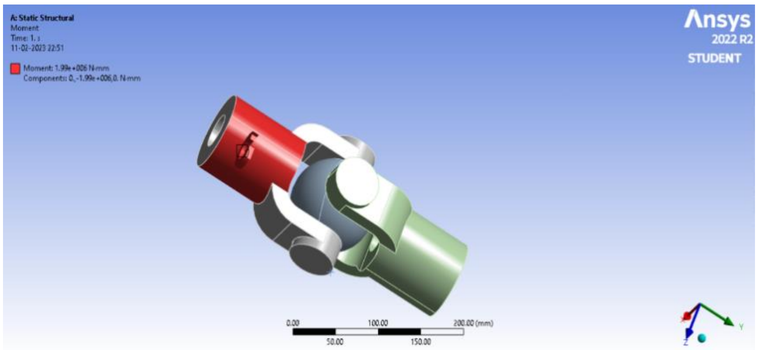

Fig.5.4:Torque applied for dynamic analysis

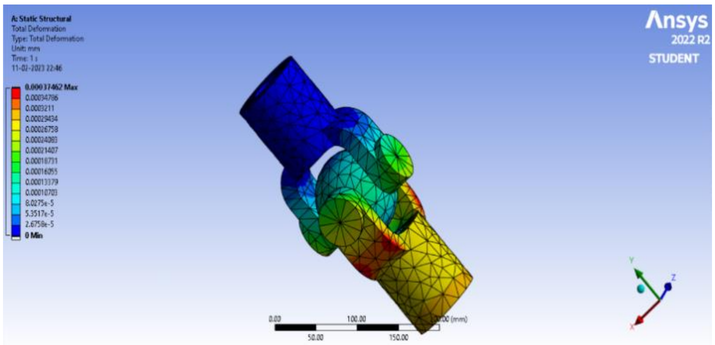

Fig.5.5:Total deformation of new coupling

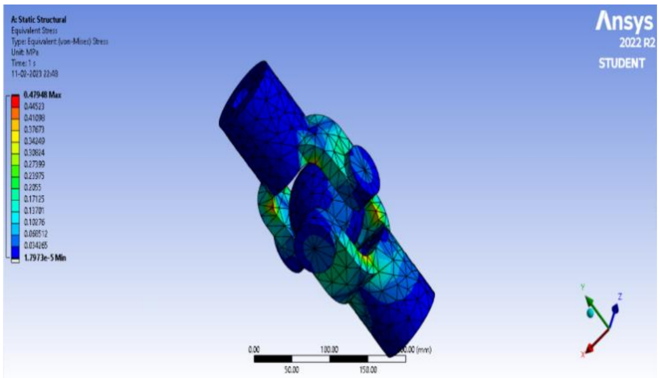

Fig.5.6:Stress Analysis of new design

VI. Future Scope

1) The universal joint can be optimised by taking into account other lighter materials as well. As a result, a new material for the universal joint can be proposed.
2)Improve the existing universal joint design and reduce weight by improving the mechanical properties of the composite material. We will determine the weight reduction in the existing model by using different materials.

VII. Results

Comparison of existing model and New Model

	Existing Model	New model	Difference
Von Mises stress	237.77MPA	183.49MPA	54.58MPA
Total Deformation	9.0577mm	0.00037mm	9.05733mm

VIII. Conclusion

Study of the Universal Joint demonstrates unequivocally that the strength of the component may be greatly increased with only a minor alteration to the current design. The design is slightly lighter after making the same alterations as before. In addition to being equally distributed across the part, the maximum stress values generated are greatly lowered. This project involves designing a universal coupling and performing a finite element analysis on it. The failure of a component can be attributed to mistakes in Manufacturing and design, shear failure, poor assembly, errors in raw materials, maintenance errors, errors in material processing, cyclic loads, drivable joint angles, wear and noise, etc. The fundamental objective of this research is to decrease shear failure. CATIA software is used to model the suggested design, while ANSYS software is used for static and dynamic analysis.

Von Mises stress and shear stress in the current design are 237.77 MPa and 64.165 MPa, respectively. Von Mises stress is decreased to 183.49 MPa following the design change to the pin. The von Mises stress is determined to be reduced from 237.77 MPa to 183.89 MPa failure is automatically reduced by comparison of the two results.

X. Acknowledgment

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