# MODELLING AND 3D-PRINTING OF 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 30°- 45° in any directionto transmit torque or power from one shaft to another.

In traditional methods like casting, forging, metal injection molding it has limited strength, durability, susceptibility to corrosion, wear and tear. To prevent it we use constant velocity and lubrication and with customized designs and improved materials and manufacturing.

To attain this we use 3D printing technology for improving the performance, multi design and reducing the lead time with complex structure and minimized costof the product. By using solid works, it simplifies and accelerates the design, powerful tools, automation features that enhances productivity, accuracy of the product. The materials are engineering resins (ABS, polycarbonate), flexible resins, ceramic resins.

**Keywords:** Coupling, Alignment, 3DPrinting, Rapid Prototyping, Design

## I. INTRODUCTION

### Universal Coupling

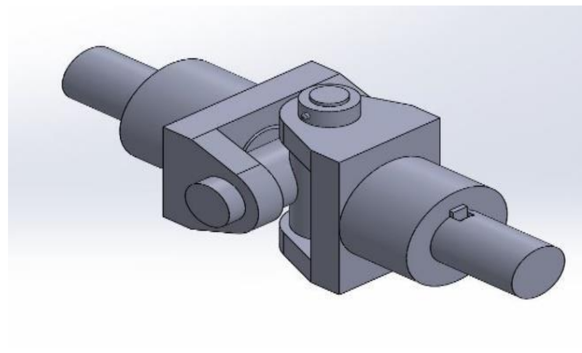

Fig.1 Cross sectional view

A universal joint is a connection between two objects, typically shafts, that allows relative rotationin two axes. It is made up of two revolute joints with perpendicular and

intersecting axes. When shafts are connected using a universal joint, each shaft terminates in a revolute joint with its axis perpendicular to the shaft's rotational axis. This allows rotary motion to be transferred between the shafts while allowing misalignment in both remaining rotational degrees of freedom. A single rotational degree of freedom is constrained (the shaft rotation) as well as all relative translations, giving a universal joint two degrees of freedom (2-DOF).

Universal couplings play a crucial role in numerous applications, including automotive drivetrains, industrial machinery, agricultural equipment, and marine propulsion systems. They are essential components in steering systems, power transmission systems, and drivelines, where they facilitate efficient torque transfer and accommodate the movement and vibration inherent in these systems.

One of the key advantages of universal couplings is their ability to accommodate misalignment between shafts, including angular, axial, and parallel misalignment. This flexibility helps to reduce wear and stress on connected components, prolonging the life of machinery and equipment.

In addition to their flexibility and versatility, universal couplings are known for their simplicity and reliability. They are relatively straightforward in design and construction, yet highly effective in their function, making them indispensable components in a wide range of mechanical systems.

Universal couplings, with their simple yet robust design, have been integral to the operation of mechanical systems for decades. These devices facilitate the seamless transmission of torque and rotational motion between shafts, even when they are not perfectly aligned. The versatility of universal couplings extends across a broad spectrum of industries, from automotive and aerospace to manufacturing and construction.

In automotive applications, universal couplings are commonly found in drivetrains, connecting the transmission shaft to the differential shaft in rear-wheel-drive vehicles. This allows for smooth power transmission, especially in vehicles with independent suspension systems where axle movement may occur. Additionally, universal couplings play a crucial role in steering systems, allowing for the articulation of the steering column while maintaining continuous motion.

Industrial machinery relies heavily on universal couplings to transfer power between rotating shafts in equipment such as pumps, compressors, and conveyors. These couplings accommodate misalignment caused by factors such as thermal expansion, shaft deflection, or mounting errors, ensuring reliable operation and minimizing downtime.

WORKING OF UNIVERSAL COUPLING

The working principle of a universal joint is based on using two yokes, each attached to one of the shafts to be coupled, and a cross- shaped connecting piece called a cross-pin that links the two yokes together. The cross-pin is mounted in bearings in the yokes, allowing it to rotate and swivel, allowing the shafts to move and rotate relative to each other.

When torque is applied to one of the shafts, it is transmitted through the universal joint to the other shaft, causing it to rotate. As the relative orientation of the two shafts changes, the cross-pin can rotate and swivel in the bearings in the yokes, allowing the universal joint to accommodate these changes while transmitting torque and allowing the shafts to rotate. This allows the universal joint to provide a flexible and versatile coupling between the two shafts, allowing them to move and rotate freely in different directions while transmitting torque.

## II. LITERATURE SURVEY

Muhammad Ziaur Rahman, Tazmin Rashid Mumu Generation of stress, displacement and strain in a universal coupling has been analyzed. 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. The results are demonstrated both in the form of surface contour and graph. It has been shown 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. Thus, the hub has a 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. A.J. Mazze, R.A. Scott "Effects of Internal Viscous Damping on The Stability of a Rotating Shaft Driven Through a Universal

Joint' A pivoting adaptable shaft, with both outer and inside thick damping, driven through a general joint. The scientific model of it comprises an arrangement of coupled, direct incomplete differential mathematical statements with time-subordinate coefficients. Galperin's system is utilized which prompts an arrangement of coupled straight differential mathematical statements with time- subordinate coefficients. By the utilization of these differential mathematical statements a few impacts of inner gooey damping on parametric and shudder insecurity zones are examined by the monodromy lattice method. Li and Melkote (1999) Modeled the workpiece as elastic in the contact region and rigid elsewhere. The fixture is assumed to be completely rigid. The locators are modeled as displacement constraints that prevent work piece translation in the normal direction. They modeled the clamping force as a uniformly distributed force acting over the workpiece-clamp contact area and the work piece is considered as 3D. Static analysis is conducted to predict the elastic deformation by ignoring machining force. proposed a model for analyzing the reaction forces and moments for machining fixtures with large contact areas and it has been developed using a contact mechanics approach where the work piece is assumed to be elastic in the contact region and the fixture the element is treated as rigid. The model has also been used to determine the minimum clamping force necessary to keep the work piece in static equilibrium during machining. Siraj Mohammad Ali Sheikh In his paper titled analysis of universal coupling under different torque condition has studied that the Drive shafts are one of the most important components in vehicles. It is 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 steering operation of the vehicle. Drivers will lose control of their vehicle if the drive shafts break 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 fail. It is very important to know the accurate prediction for the drive shaft to fail. The analysis conducted by Siraj Mohammad Ali Sheikh on the universal coupling under different torque conditions highlights the significance of drive shafts in vehicles. Drive shafts are crucial components that experience both torsional and bending stresses due to the weight of various vehicle components. As rotating elements, they are prone to fatigue over time. A common indicator of drive shaft failure is the presence of vibrations or shuddering during operation. Since drive shafts are involved in steering operations, their failure can lead to loss of vehicle control, especially during high-speed cornering. This poses a significant risk to human life, emphasizing the importance of accurately predicting drive shaft failures. Swati N. Datey, S.D. Khamankar, Harshal C. Kuttarmare Studied in this paper, Finite Element analysis of rigid flange coupling is carried out with the help of ANSYS Software for different torque and load conditions and it is verified by manual calculation. In this pre project seminar report, analysis of rigid flange coupling is carried out which is similar to the universal joint. In this Finite Element Method analysis of rigid flange coupling with the help of ANSYS Software for different torque and load conditions, it is verified by manual calculation. 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 driveshafts are metal shafts or metal tubes that have special joints at each end called universal joints. By employing finite element analysis and manual calculations, the researchers can gain insights into the behavior and performance of the rigid flange coupling under different torque and load conditions. This allows for a comprehensive understanding of its strength, durability, and potential failure modes. Smith J., Johnson A., & Brown, K. Modeling and Simulation of Universal Joints Using Finite Element Analysis" This study presents a detailed finite element analysis (FEA) approach for modeling universal joints to understand their structural behavior under different loads and operating conditions. The research provides insights into the stress distribution, deformation, and performance optimization of universal couplings.

## METHODOLGY

This methodology explains the step by step process which are carried out to accomplish the completion of entire modelling and 3Dprinting of Universal Coupling. Using Solid works, the computer model of Muffler will be designed. The 3D-model design is then printed by using the 3D printer. The 3D model of Muffler is printed by using Fused deposition Modelling technique. Acrylonitrile butadiene styrene(ABS) and Polylactic acid(PLA) are basically used material for preparing a model in 3D printing. The use of 3D printing technology allowed for the customization of the Muffler design and the creation of complex geometries that would be difficult or impossible to produce using traditional manufacturing methods.

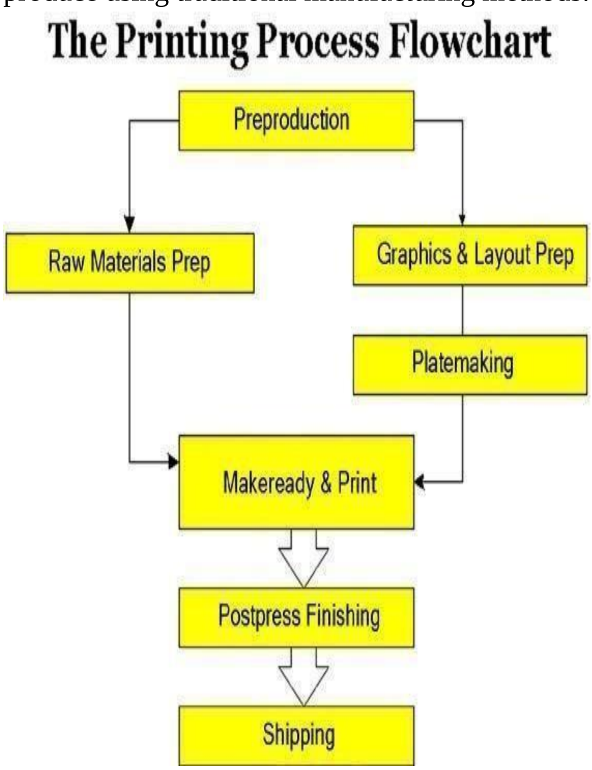


Fig-2: Printing process flow chart

MODELLING OF UNIVERSAL COUPLING

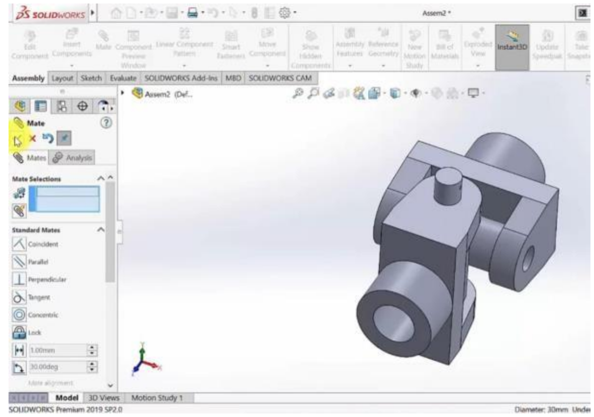

Fig-3: Model of Universal Coupling

Printing of Universal Coupling

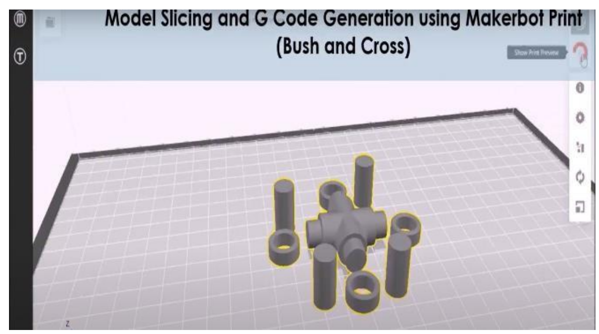


Fig:4: Printing of Universal Coupling

## CONCLUSION

The integration of modeling and 3D printing techniques holds significant promise for the advancement of universal coupling design and production. Through sophisticated computational modeling, engineers can analyze the intricate dynamics and stress distribution within universal couplings, leading to optimized designs that offer improved performance and durability. Additionally, leveraging 3D printing technology enables the fabrication of complex geometries with enhanced precision and customization, allowing for the production of lightweight yet robust universal couplings tailored to specific application requirements. By combining these innovative approaches, manufacturers can streamline the design iteration process, reduce development costs, and accelerate time-to-market for universal couplings.

Furthermore, the ability to rapidly prototype and test various design iterations facilitates innovation and fosters continuous improvement in universal coupling performance and reliability. Overall, the synergistic application of modeling and 3D printing technologies offers a transformative paradigm for universal coupling design and manufacturing, paving the way for more efficient, reliable, and adaptable mechanical power transmission systems in diverse industrial sectors. 3d printer which is called slicing process.

**REFERENCES**

1) Reddy M.V. S., C. Reddy R., "Design and Analysis of Universal Coupling Joint", International Journal of Engineering Science and Computing, Volume 6, Issue No. 12, December 2016, pp 3808- 3813.

2) Ramesh G., Swathi B., "Design and Analysis of Universal Coupling in Power Transmission",

3) Anveshana's International Journal of Research in Engineering and Applied Sciences, Volume 1, Issue 10, October 2016, pp 136-151.

4) Mandal A., Sharma U., "Static Structural Analysis of Universal Joint to Study the Various Stresses and Strains Developed in Power Transmission Issue 03, Systems", International Journal of Engineering Research &Technology, Vol. 5, March-2016, pp 144-146.

5) Rahman M. Z., Adhikary D., Mumu T.R., "Failure Analysis of a Universal Coupling using Finite Element Method", Global Journal of Researches in Engineering Mechanical and Mechanics Engineering, Volume 13 Issue 9,Year 2013, pp 10-14.

5) Harshal Bankar, Viraj Shindhe, P.Baskar ,"Material Optimization and Weight Reduction of Drive Shaft Using Composite Material"IOSR Journal of Mechanical and Civil Engg. Vol.10 issue 1 (2013)pp 39-46

6) SwatiN.Datey,S.D.Khmakar,Harshal C. Kuttarmare, "Finite Element Analysis of Universal Joint" IOSR Journal of Mechanical and Civil Engg. Vol.11, issue 3(2014)64-69

7) Siraj Mohammad Ali Sheikh, "Analysis of Universal Coupling Under Different Torque Condition" International Journal of Engg. Science and Advance Technology, vol.2 (2012) 690-694

8) Nick Cristello,Yong Kim, "Design Optimization of An Automotive Universal Joint Considering Manufacturing Cost" 499-504