IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 7, June 2022

Design and Analysis of FDM Gear Coupling

Mugdha Shinde[1], Pruthviraj D. Patil [2],Rutuja Bhangale[3], K. P. Pandey[4]
Student, Department of Mechanical Engineering[1]
Assistant Professor, Department of Mechanical Engineering[2]
JSPM Rajarshi Shahu College of Engineering, Pune, India[1,2]
Lecturer, Department of Mechanical Engineering, Pimpri Chinchwad Polytechnic, Pune, Maharashtra, India [3,4]

Abstract:*In many transmissions mechanism and drives the couplings play a crucial role of providing the vibration free, safe transmission of power from input to output shaft of equipment. Although the conventional rigid couplings when properly designed, selected and maintained, can provide good service life. Gear couplings are standard, however in some cases customized couplings are needed which are not possible to produce because of very high molding costs. Project aims at design, modeling, analysis and comparison testing of the gear coupling that is 3-d printed. The modeling of the compact drive system has been done using Unigraphix Nx-8 whereas the analysis is done using Ansys Workbench-16.0.*

Keywords: Gear Coupling, Customized,Modeling, Analysis, 3-D printing. etc.

I. INTRODUCTION

Gear couplings are commonly used industry, and majority of the plastic moulded couplings have gone from curiosity to industrial mainstay in the past 50 years. today they transfer torque and motion in products as diverse as cars, watches, sewing machines, building controls, and missiles. even with all the ground they've gained, their evolution is far from over as new and more demanding gear applications continue to emerge. plastic gear couplings are serious alternatives to traditional metal gear coupling in a wide variety of applications. the use of plastic gear coupling has expanded from low-power, precision motion transmission into more demanding power transmission applications. conventional method of manufacturing is the plastic molding, but this is only for a substantial batch quantity. in present day situation many at times it is required to produce small quantity of products for which plastic molding is not a economical solution.

Figure 1: Gear Coupling

In such cases the method of FDM (Fused deposition modeling) can be used. But though the method is extremely fast and economical for small batch quantity, the performance of parts produced by this method are yet to be proven for strength and durability. Gear couplings have been likened to a one-to-one gear box, that is, torque transfers from hub teeth to sleeve teeth and across the shaft gap with no change in RPM.

Gear couplings are standard, however in some cases customized couplings are needed which are not possible to produce because of very high molding costs.

II. LITERATURE REVIEW

Chen Feng et al (1): The authors developeda coupling using elastic gears and carried out the analysis of the same to verify the strength conditioning of the device and establish a 3-d model.

Mikhaylov Aleksandr et al (2): The paper deals with the gear coupling tooth development using a special forming spatial tool that uses kinematic method by application of thermo-mechanical treatment method.

M.M.Calistrat et al (3): The authors discuss the failure of the gear coupling hub, sleeve in the circumstance of block up of the coupling, and they found out that the lubrication plays a vital role in the service life of the coupling.

Stephen R. Locke et al (4): The authors discuss the credible failure modes of the gear coupling the authors bring forth the most common coupling failure modes and cite examples of deterioration and propose options for intervention in sufficient time to prevent catastrophic failure.

JonR. Mancuso et al (5): The authors discuss the modes of failure of the gear coupling sleeve and hub in the conditions of overload the coupling,and role that the lubrication plays in the service life of the coupling and how they can be replaced by flexible couplings to reduce chances of failure.

III. LITERATURE GAP

The conventional gear coupling systems do not provide overload safety. The non-standard gear couplings are difficult and costly to manufacture Although the conventional rigid couplings when properly designed, selected and maintained, can provide good service life but they do-not provide the desired safety against the overloads. Conventional method of manufacturing is the plastic molding, but this is only for a substantial batch quantity. In present day situation many a times it is required to produce small quantity of products for which plastic molding is not an economical solution. In such cases the method of FDM (Fused deposition modeling) can be used.

IV. DESIGN OF PART ASSEMBLIES

4.1 Design of Input Coupling Gear

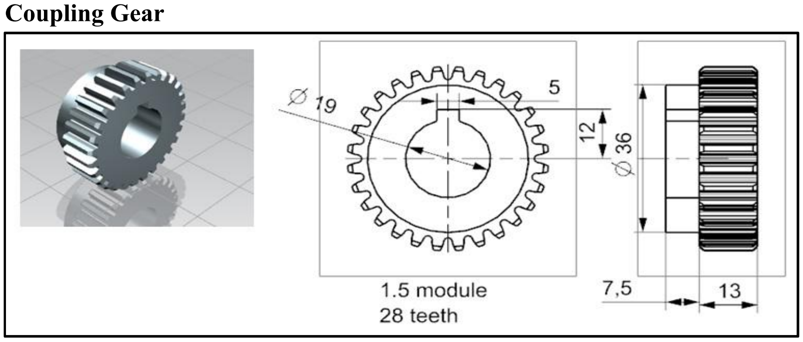

Figure 2: Input Coupling Gear

Table1: Material Selection for Input Coupling Gear

Designation	Ultimate Tensile Strength N/mm^2	Yield Strength N/mm2
Abs Polymer	60	42

Check for torsional shear failure of shaft:

$Td = \Pi/16 \times fs_{act} \times (D^4 - d^4) /D$

$\Rightarrow fs_{act} = 0.075$ N/mm^2

As $fs_{act} < fs_{all}$

$\Rightarrow$ Input coupling gear is safe under torsional load.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 7, June 2022

4.1.1 Analysis of Input Coupling Gear (Torsion):

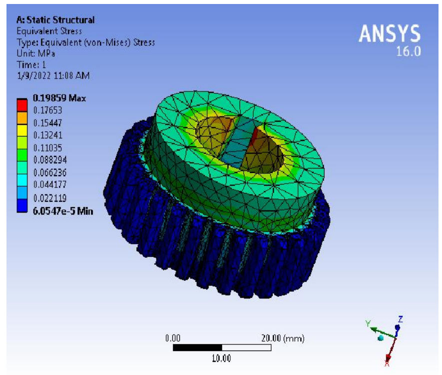

Figure 3: Von mises stress of Input Coupling Gear

The maximum theoretical stress in the input coupling gear under torsional load is 0.075MPa whereas the analytical stress is 0.199 MPa thereby suggesting that the design of the input coupling gear is safe under given system of forces.

4.1.2 Analysis of LH Gear Considering Tangential Tooth Load:

Tangential tooth load = T/ R = 640 / ((28x1.5/2) = 30.5 N

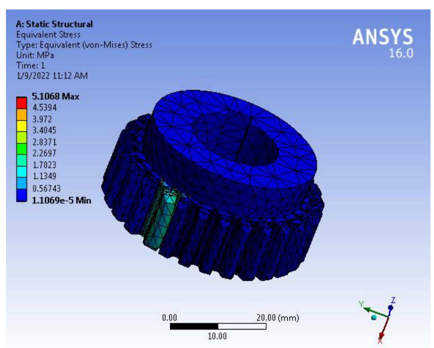

Figure 4: Von mises stress of Gear

The maximum stress induced in the part due to the tangential tooth load is 5.1058 MPa thereby suggesting that the design of the input coupling gear is safe under given system of forces.

4.2 Design of Gear Coupling Sleeve:

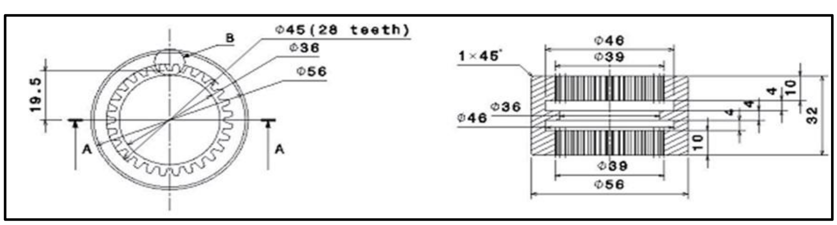

Figure 5: Gear Coupling Sleeve

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Volume 2, Issue 7, June 2022

Impact Factor: 6.252

Table2: Material Selection for Gear Coupling Sleeve

Designation	Ultimate Tensile Strength N/mm^2	Yield Strength N/mm2
Abs Polymer	60	42

Check for torsional Shear Failure of Shaft:

$Td = \Pi/16 \times fs_{act} \times (D^4 - d^4)/D$

$\Rightarrow fs_{act} = 0.07 \text{ N/mm}^2$

As $fs_{act} < fs_{all}$

$\Rightarrow$ Gear coupling sleeve is safe under torsional load.

4.2.1 Analysis of Gear Coupling Sleeve (Torsion):

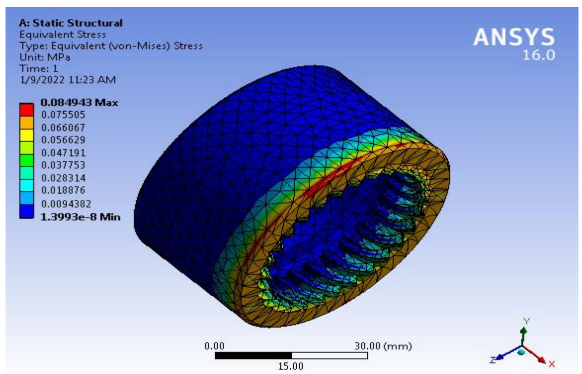

Figure 5: Von mises stress of Gear Coupling Sleeve

The maximum theoretical stress in the input coupling gear under torsional load is 0.07 MPa whereas the analytical stress is 0.0849 MPa thereby suggesting that the design of the input coupling sleeve is safe under given system of forces.

4.2.2 Analysis of Gear Coupling Sleeve Considering Tangential Tooth Load:

Tangential tooth load = T/ R = 640 / ((28x1.5/2) = 30.5 N

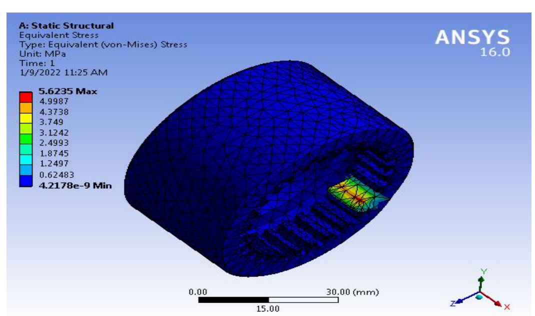

Figure 6: Von mises stress Gear coupling Sleeve with tangential tooth load

The maximum theoretical stress in the gear coupling sleeve under torsional load is 0.07 MPa whereas the analytical stress is 0.08 MPa. The maximum stress induced in the part due to the tangential tooth load is 5.6235 MPa thereby suggesting that the design of the gear coupling sleeve is safe under given system of forces.

V. RESULT DISCUSSION

1. Although the conventional rigid couplings when properly designed, selected and maintained, can provide good service life but they do-not provide the desired safety against the overloads. Conventional method of manufacturing is the plastic molding, but this is only for a substantial batch quantity. In present day situation many at times it is required to produce small quantity of products for which plastic molding is not a economical solution. In such cases the method of FDM (Fused deposition modeling) can be used.
2. The maximum theoretical stress in the input coupling gear under torsional load is 0.075 MPa whereas the analytical stress is 0.199 MPa. The maximum stress induced in the part due to the tangential tooth load is 5.1058 MPa thereby suggesting that the design of the input coupling gear is safe under given system of forces.
3. The maximum theoretical stress in the gear coupling sleeve under torsional load is 0.07MPa whereas the analytical stress is 0.08 MPa.The maximum stress induced in the part due to the tangential tooth load is 5.6235 MPa thereby suggesting that the design of the gear coupling sleeve is safe under given system of forces.

VI. CONCLUSION

Gear couplings are standard, however in some cases customized couplings are needed which are not possible to produce because of very high moulding costs. Project aims at design, modelling, analysis and comparison testing of the gear coupling that is 3-d printed. The modelling of the compact drive system has been done using Unigraphix Nx-8 whereas the analysis is done using Ansys Workbench-16.0 the parts are found to be safe by both methods. The developed gear coupling will integrate with overload coupling to develop a compact drive system.

REFERENCES

[1] Chen Feng,Li Zheng-feng, Liu Yuan-xiang ' Design and calculation of a new type of elastic gear coupling and finite element analysis' Advanced Materials Research Vols. 989-994 (2014)

[2] Mikhaylov Aleksandr,Grubka Roman,Lahin Aleksey, Nedashkovskiy Aleksandr,and Guitouni Ahmed Structural and Technology Support Quality Improvementof Gear Coupling Applied Mechanics and Materials Vol 371 (2013)

[3] M. M. Calistrat ' Friction Between High-Speed Gear Coupling Teeth' *J. Mech. Des* 103(1), 54-58 (Jan 01, 1981

[4] Stephen R. Locke 'Coupling credible failure modes and owner options to intervene' Turbomachinery Symposium September 30 – October 3, 2013

[5] JonR. Mancuso, C. B. (Barney) Gibbons Robert E. Munyon ' The application of flexible couplings for turbomachinery'

[6] Adelaide Nespoli, Enrico Bassani, Elena Villa, and Francesca Passaretti ' Study of a Torque Limiter Based on NiTiPseudoelastic Tapes' Adv. Eng. Mater. 2021

[7] Yi Guoa, Scott Lambert a, Robb Wallena, Robert Errichellob, Jonathan Keller ' Theoretical and experimental study on gear-coupling contact and loads considering misalignment, torque, and friction influences'Mechanism and machine theory 2016.

[8] Jyun Rong Zhuang, HayatoNagayoshi, Hirotoshi Kondo, Hee-hyol Lee 'The Applicability of an Assistive Walking Device IntegratingOverload Protection Mechanism Using a Torque Limiter' 2018 IEEE/ASME International Conference on Advanced Intelligent Mechatronics

[9] MarilenaGhi¸tescu, Ion-Marius Ghi¸tescu, Paul Nicolae Borza and Sorin Vlase ' A New Optimized Solution for a Flexible Coupling with Bolts Used in the Mechanical Transmissions' MDPI Journal Symmetry 2021, 13, 171

[10] Xiang Gao, Cheng Lin ' Electromechanical Coupling Approach for Traction Control System of Distributed Drive Electric Vehicles E3S Web of Conferences 23 6, 01007 (2021) ICERSD 2020.