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Design and Topology Optimization of Three Stage Spur Gearbox

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ABSTRACT

Topology optimization is a whole new level of process of developing creative design to achieving challenges of new world. Now a day's gears become vital elements of mechanisms in many machines. In this review paper, the weight of gears can be reduced using topology optimization which construct gearbox with optimum designing of gears, reduced one shaft and minimum thickness of gear box body. The three-dimensional solid model generated in CAD software, and create model in Autodesk Inventor 2015. This model of the spur gears is imported in ALTAIR software. Then optimization of weight reduction, shape and strength is done by using ALTAIR software. The topology optimization of spur gear can reduce the weight of gearbox and the developed gearbox is reliable in performance with high efficiency and reduced cost.

Keyword:- Topology optimization, three stage gearbox, weight reduction,

Introduction:

Gears are machine elements used to transmit power and motion between driver and driven shafts. They vary from a tiny size in toys to the large gears used in ships. The gears are used to change the speed and power ratio as well as direction between input and output shaft. A gearbox contains a group of gears to achieve a gear ratio between the driver and driven shafts. A gearbox can be defined as a mechanical system used to transmit power in certain distance, usually involving a change in speed and torque. The Spur Gears are comparatively easy to manufacture, economical and not required high degree of accuracy for assembly. Spur gears are most frequently used drive transmission in many applications. They are designed using standard procedure which considers certain parameters. These design parameters lead to heavy gears. The weight of gears can be reduced using topology optimization. The increase in rotational inertia caused by the weight it decreases the efficiency at the initiation of a transmission drive. Topology Optimization is a key part of design for additive manufacturing. Topology optimization is aimed attending the best use of material within a given design space filling requirements on stiffness, displacement, eigenvalues, etc. In short, the optimization seeks to and the optimal load path for a particular load and boundary condition. With the rise of the Finite Element Method (FEM), algorithm-based optimization has become available not only to the expert user.

PROBLEM SOLUTION :

The gears are most crucial part of gearbox, there is increasing demands of light weight gearbox with robust construction, reliable performance, high efficiency, economy and long life. The solution leads towards the topology of three stage gearbox.

Literature Survey:

P Chandra Rao et al.[1] conclude the weight of the conventional gear box can be reduced without compromising the efficiency by using topology optimization techniques from ANSYS software. Analysis is carried out on optimized gear and regular gear. by comparing the result optimized gear is selected.

Vijay Kanase et al.[2] conclude the gearbox designed and fabricated as a reliable, safe and cost effective. They were evaluated analytical calculations using Hypermesh for finite element analysis. After exploring various methods and further heat treated to improve their wear strength.

VaibhavPimpalte et al.[3] found gears generally fail when the working stress exceeds the maximum permissible stress. His research intends to identify the magnitude of the stresses for a given configuration of a two-wheeler gears transmitting power while trying to find ways for reducing weight of the gear. They concluded lightness of the gear for a given purpose while keeping intact its functionality thus reducing the material cost of the gear.

Mit Patel et al. [4] found generally gears fail when the working stress exceeds than the maximum permissible value. Use finite element analysis method for the helical gear tooth using ANSYS. Hence the results, it was possible to reduce the weight of these gears without much increase in stresses and keeping the functionality of gears intact.

Ramadani R. et al. [5] aimed to reduce gear

vibration and weight by modifying its body structure. The primary objective was to reduce vibration and noise of spur gear. They replaced solid gear body by lattice structure. In this research they experimentally confirmed that cellular lattice structure of a gear body in addition of the polymer matrix may significantly reduce the vibration

Adis J. Muminovicet. al.[6] aimed to gear tooth topology optimization. They concluded by using advance manufacturing methods gear tooth can be produced in a form of shell body with empty space inside. Optimization goal was to find optimal shell thickness of shell body spur gear tooth.

KunalMenavlikaret. al.[7] designed and analysed a two-stage reduction automotive gearbox used in an All-Terrain Vehicle competing in BAJA SAE INDIA. The gearbox is coupled to a Continuously-Variable Transmission which is powered by a 7.5KW- four stroke gasoline engine. As a result, they found the topology optimization significantly contributed in reducing the overall weight of the vehicle thereby improving the acceleration by 15%.

MetinZEYVELİ et. al.[8] found traditional methods used in gearbox design. In the basic software Genetic Algorithm (GA) was applied to the problem with the objective function of minimising of volume of gear trains. The objective function was constrained by bending strength, contact stress, face width and number of pinion and gear teeth. Design optimisation of a two-stage gearbox by using Genetic Algorithm.

P J. Swaroopet. al.[9] found bending and surface strength of the gear tooth are considered to be one of the main contributors for the failure of the gear in gear set. When gears are produced in bulk, it requires more material which results in more expenditure. The shape of the spur gear optimized by using Fusion 360 software. The design optimization helps in reducing 75.28% of the structure weight.

FatmirAzemiet. al.[10]They performed shape optimization of spur gear, found bending and surface strength of the gear tooth are considered to be one of the main contributors for the failure of the gear in gear set. The three-dimensional solid model can be generated in CAD software they have created model in Autodesk Inventor 2015. Then spur gear shape optimization performed by using ANSYS software.

Proposed Work:

I. Theoretical Work:

1. To review existing literature to study current trends in topology optimization of gears and manufacturing.
2. Design gearbox as per required specifications
3. Preparation of 3D model for topology optimization.

II. Analysis Work:

Analysis of designed gearbox using ALTAIR topology optimization/analysis software.

III. Manufacturing work:

Suitable manufacturing methods will be employed to manufacture/fabricate the components and then assemble the gearbox. The manufacturing/fabrication will be carried out as per layout shown below.The proposed model has 1 hp single phase 1440 RPM foot mounted induction motor, motor shaft coupled to the hollow input shaft of gearbox, gearbox housing provides bearing support for holding input and output shaft, it also forms a lubrication tank to lubricate gears. The pinion 1 has 19 teeth which messed to idler gear-1, Gear -1 coupled to pinion-2 with so that gear-1 and pinion-2 perform as single solid unit, which turns gear-2.Similarly gear-2 and pinion-3 are coupled, the final reduction of 1:50achieved at gear-3.

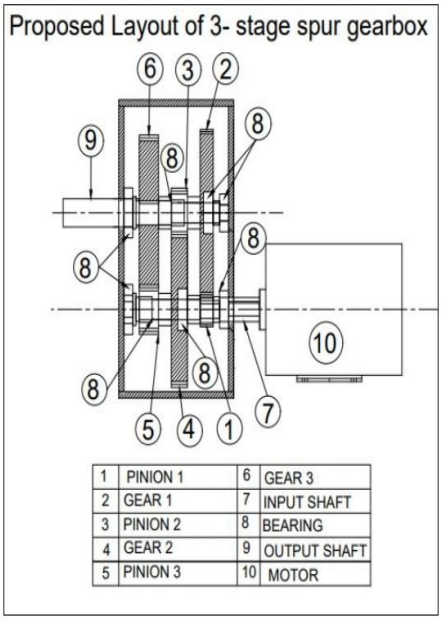

Fig.1 Optimized Design

CONCLUSION:

Study of literature survey, indicate weight reduction, cost effectiveness is main issue and weight reduction is possible by topology optimization without much increase in stresses and keeping the functionality of gears intact. Design of three stage gearbox is totally different which is manufactured by low cost, less weight and for high torque applications.

REFERANCES:

1. P Chandra Rao, M Anil Kumar, M Nirmal Devi Kiran(2019), "Topology Optimization of Gear Box using ANSYS" International Journal of Electrical Electronics Computers & Mechanical Engineering (IJEECM) ISSN: 2278-2808 Volume 9 Issue 11 (Nov. 2019)

2. Vijay Kanase, DnyanadaRane, Vishal Dongare, RhuturajShinde, AtulTangade(2017),"Design And Manufacturing Of 2-Stage Speed Reducer For A BAJA All Terrain Vehicle" International Journal of Mechanical Engineering and Technology IJMET) Volume 8, Issue 10, pp. 42–52, ISSN Print: 0976-6340 and ISSN Online: 0976-6359, (October 2017)

3. VaibhavPimpalte, Prof. S. C. Shilwant(2017), "Topology Optimization of Gears from Two Wheeler Gear Set Using Parametric Study" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 22781684, p-ISSN: 2320-334X, Volume 14, Issue 1 Ver. II (Jan. - Feb. 2017)

4. Mit Patel, HadiyaValiulla, VinayKhatod, BhavinChaudhary, VikasGondalia(2019), "Topology Optimization of Automotive Gear using Fea" (International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-4 (November 2019)

5. Ramadani R, Belsak A, Kegl M &Pehan S " Topology optimization based design of lightweight and low vibration gear bodies" Inst. J. Simul 17 1, 92-104 ISSN 1726-4529 (2018)

6. Adis J. Muminovic, AdilMuminovic, ElmedinMesic, IsadSaric, NedimPervan(2019), "Spur Gear Tooth Topology Optimization: Finding Optimal Shell Thickness for Spur Gear Tooth produced using Additive Manufacturing" TEM Journal. Volume 8, Issue 3, Pages 788-794, ISSN 2217-8309, DOI: 10.18421/TEM8313 (August 2019)

7. KunalMenavlikar, SnehalWadhokar, ArbazShaikh, AniruddhaKulkarni(2019), "Design and Topology Optimization of two stage Gearbox for All-Terrain Vehicle" International Journal of Innovative Research in Science, Engineering and Technology, ISSN(Online): 2319-8753 ISSN (Print): 23476710, Vol. 8, Issue 2, (February 2019)

8. Metin ZEYVELİ, Cevdet GÖLOĞLU (2019), "Design Optimisation Of Two Stage Gearbox With Helical Gears" 5th International Symposium on Intelligent Manufacturing Systems, May 29-31, 2006: 724-733 Sakarya University, Department of Industrial Engineering (19 January 2015)

9. PJ. Swaroop, S. LokeswaraManikanta, N. PrabhuTeja, C. V. Vincent, S. Thirumavalavan (2019), "Design, Analysis And Shape Optimization Of Spur Gear For Material Reduction" International Journal of Scientific Research and Review Volume 8, Issue 1, ISSN NO: 2279-543X (2019)

10. FatmirAzemi, BekimMaloku, MusajTerbunja (2016), "A Review On Design, Analysis And Shape Optimization Of Spur Gears Of The Gear-box Reduction Of The Working Wheel Of The Excavator SCHRS 1300 24/5.0 Using CAD/CAE Sostware" International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 4, Issue-7 (Jul.-2016)

11.MariangelaCasiello (2018), Master's Degree Thesis "Static and Dynamic Topology Optimization for Aeronautical Gears" POLITECNICO DI TORINO Corso di LaureaMagistrale in IngegneriaAerospaziale Aerospace Engineering: Propulsion Systems (December 2018)

12. Naveen Kumar, Mr.VaibhavChittoria, Mr.UtkarshUpadhyay (2020), "Spur Gear Designing and Weight Optimization" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by : Vol. 9 Issue 03 (March-2020)

13. Anjali Gupta (2014), "Design Optimization of the Spur Gear Set" International Journal of Engineering Research & Technology (IJERT) IJERT ISSN: 2278-0181, Vol. 3 Issue 9 (September- 2014)

14. N. Godwin Raja Ebenezer, R. Saravanan, S. Ramabalan, S. Navaneethasanthakumar "Advanced helical gear reducer design optimization through nature inspired algorithms" World Scientific News 77(2) (2017) 267-280, EISSN 2392-2192. (2017)

15. Edmund S. Maputi1, and Rajesh Arora "Design optimization of a three-stage transmission