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Review Paper on Design Analysis and Modification of Spur Gear

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Abstract

This review paper gives the information about design analysis of spur gears by comparing analytical results to calculate results. Thus this review paper mainly contributes to the modification had done in spur gear for better results. Many authors have used different approaches the goal they were working on. Stress and gear failure are mainly found using FEA and AGAMA standards. This review paper consist modification, use of software in design analysis, and analytical methods for the spur gears

Keywords: ANSYS, Composite gear, Design analysis, Spur gear.

Introductions

Gear drives are one of the most widely used mode in power transmission system with advantage of large power, high efficiency, and long service life. Spur gear is the most common type of gears. They are used to transmit rotary motion between parallel shaft i.e. they are usually cylindrical in shape, and the teeth are straight and parallel to the axis of rotations. Sometime spur gears are used to once to create very large reductions. Spur gears are used to transmit the power between parallel shafts. Spur gears give 98%-99% operating efficiency. This gear can be meshed together correctly only if they are fitted to parallel shaft. The main reason for the popularity of spur gear is their simplicity in design and manufacturing .Gear is component within a transmission device transmits rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel. mesh with other gear teeth, allowing force to be fully transferred without slippage, depending on their construction and arrangements, geared devises can transmit forces at different speeds, torques, or in a different direction, from the power sources. Gears are a very useful simple machine. The most common situation is for a gear to mesh with another gear, but a gear can mesh with any device having compatible teeth, as linear moving racks.

Literature review

[1]. Haider M. Mohammad and Farah M. Abdul Razzaq had done work on optimisation of sustainable spur gear manufacturing. In this work various parameter are compared to optimise the manufacturing of spur gear by using genetic algorithm. The material used for manufacturing is AISI 104S medium carbon steel. Using milling machine at different feed rates (f), Spindle speed (v) and at constant depth of cut (dc). Five cutting speeds and three feed rates were used 45, 63, 90, 125 and 180 rpm cutting speed and 128, 35 and 45 (mm/mm) feed rates. Hardness for gears is calculated Rockwell method

HRB= $(A+V/B+C*F^2)+ D*Ln(V)$

Values of constants are

A	B	C	D
120.2	-1.897	0.0000243	48.98

For tooth surface roughness

Ra=1/L {[Y(X)] dx

Where L is sampling Length and Y is ordinates of the profile curve.

Results

Results obtained from this experiment are very interesting and intrigues.

- Surface roughness by empirical equation was in the favour experimental values. Correlation coefficient reach to 0.9588
- With the increase in cutting speed roughness factor values are decreased. As a result in smoother surface, but with little exception roughness factor is lowest when cutting speed is 162.28 rpm.
- It is observed that roughness factor decreases with increase in feed rate with an expectation when spindle is moving with 180 rpm roughness increase with increase in feed rate.
- Results obtained of hardness by empirical values equations are shown to be agreed well against experimental values, the correlation coefficient (R) reaches to 0.9670.
- The maximum hardness is obtained when cutting speed is 90 rpm. Cutting speed ranging from 45-90 rpm hardness increases at 90 rpm. With the increase in feed rate after 90 rpm hardness from range 90-180 rpm decreases.
- Hardness is independent to the factor of feed rate
- Maximum efficiency obtained is 59.94% at the rate of 45 (mm/mm) feed rates.

[2]. Michael Gebremariam, Ashish Thakur, Equbamariam leake and Daniel Tilahum had done work on effect of change of contact ratio on contact fatigue stress of involutes spur gears by using CATIA and SOLIDWORKS software for involute spur gear models and stress analysis are done by ANSYS workbench (FEA). In this work ANSYS workbench results are compared with results of the AGMA gear formula results. Six models with different contact ratio but same gear diameter, number of teeth and same gear ratio are taken for analysis. Analysis is carried out with the help of the ANSYS workbench. For contact ratio smaller than 2 gearing the maximum load of 100% is taken by single tooth at the highest point of single tooth contact, at the tip of the teeth only 40.2% load is shared for the contact ratio of 1.64 gear pair. Highest contact ratio e.i. 2 gearing the maximum load of 67.7% load takes at first lowest pointing of double tooth contact and only 33.7% load is shared at the tip of the teeth. Maximum and minimum percentage of load shared in the double tooth contact bands are 59.98% and 40.2%. in this work. The von mises stress ate the meshes is calculated based on the tooth load distributed on a unit contact area of the that surface increases in double teeth contact region, resulting a lesser von misse stress for the contact ratio of 2 gearing the maximum stress teeth is 311.80 MPa corresponding to 11.65 radial rotation angle, and stress on tip and root part of teeth are 207.58MPa and 229.79MPa respectively. Results comparison of theoretical (AGMA) and ANSYS (FEA) are as follows. Results for contact stress calculated by ANSYS are lower than analytical results. The maximum error calculated is 2.38% for contact ratio of 1.624 and minimum is 1.57% for contact ratio of 2. As contact ratio increases stress cycle factor pitting resistance decreases. On increasing contact ratio number of load cycles expected by pitting also increases. As conclusion authors stated that stresses on spur gear teeth can be change with change in contact ratio of gears. The maximum percentage of load sharing at the normal contact ratio CR<2 the maximum contact stresses at critical load sharing. From 1.9 to 2.0 contacts ratio decrease of stresses was more than the decrease of stresses in any other two successive cases.

[3]. Mr.B.Narenathiran, A.wajid sharieff and R. Roshan Johnny had done work on design and analysis of spur gearing aluminium silicon carbide metal matrix composite. In this work gear material is casted by stir casting method. Material is prepared with three different compositions of aluminium and silicon carbide. During the preparation for attaining the wettability of material borax powder is added. Composition is which aluminium and silicon carbide are added are 90:10, 80:20 and 70:30. The project specimen is prepared to run hardness impact, tensile test. Spur gear machined with dimensions of pitch circle diameter= 90mm, number of teeth=60, outside circle diameter=100mm, circular pitch=30mm, dedendum circle diameter=80mm, dedendum=10mm, addendum=10mm. Hardness test shows the composition with 90% aluminium and 10% silicon carbide has maximum hardness of 78kgF and it decreases as we add silicon carbide in it. Same results are concluded for impact test and tensile test. Static structural analysis is done in ANSYS R15.0 taking 15000kN load. Form static analysis it is proved the composition of 90% aluminium and 10% silicon carbide shows lesser deformation on applying load of 15000kN. The density porosity test shows 90% aluminium and 10%silicon carbide is less porous than other compositions. Fatigue analysis is done on software ANSYS 16.0. Material with composition of 90% aluminium and 10% silicon carbide has maximum lowest safety factor and life cycle are same for all the three compositions that is 1e6 cycles (a million cycles). In conclusion of this project is that better results are obtained when the composition of material is 90% Al and 10% SiC. Gears manufactured form this material provides less weight compared to the conventional gears (cast steel). These gears are able to transmit 40kW power. Gears manufactured by this composition can easily take place of current gears of cast steel.

[4].M.Keerthi, K.Sandya,K.Srinivas had done work on static and dynamic analysis of spur gear using different materials. In the project spur gear are modelled in solidworks and static structural analysis and model analysis is odne on "ANSYS". In this work different materials are used to reduce the stress distribution, deformation and weight of spur gear. Structural Steel, gray cast Iron, Aluminium Alloy and Epoxy Eglass UD are the materials used in this project, using solidworks spur gear models are created and these models are exported to hypermesh to mesh component, gear used in project is with dimension module=10mm, pitch circle diameter=180mm, base circle diameter=169.145mm,outside circle diameter=200mm, clearance=1.57mm, addendum=10mm, dedendum=11.157mm, centre distance between two gears =180mm. Results from this project are very fascinating , for structural steel with torque, T=135 NM total deformation is found 0.0015 and von-mises stress is 3.4724, for gray cast iron total deformation is 0.0027 and von-mises stress is 3.4464. Aluminium Alloy total deformation is 0.0773 and von-mises stress is 3.5230. Epoxy Eglass UD total deformation is 0.0027 and von-mises 5.2634. Natural frequency at 10 modes for different gear materials. Maximum and minimum W_n for structural steel are 6399.7Hz and 2019.4Hz respectively for gray cast iron 4990.8Hz and 1575.2Hz, aluminium alloy 6353.2Hz and 2003.8Hz. As in conclusion authors stated that stress values are calculated for composite materials are almost same as to structural steel, gray cast iron and aluminium alloy. Composite materials is more than capable of using in automobile vehicle gear boxes instead of existing casting steel and these gears gives better results.

[5]. Pinaknath Dewanji had done work on design of spur gear by FEA and ANSYS software. In this work there are two types of analysis were done. Static analysis and Dynamic analysis both of them were done by using Catia for modelling and ANSYS for analysis.

Static Analysis

In static analysis Pinaknath Dewanji analyse the analytical results and ANSYS results. Analytical results were found with basic values of various parameters. Tangential load Ft=1200n(aproxx), height of tooth(h)=11.25mm, face width(b)=50mm, thickness(t)=10.614mm(at root). In this paper stress was found using flexure formula. Deflection was found by using Castigliano's theorem. Castigliano's theorem is based on strain energy. Analysis by using ANSYS was done on one tooth which was divided into 25 sections. The model of teeth was done in Catia both the stress and deflection were found by using ANSYS software. The results indicated that stress found by ANSYS with accuracy of 99.45% and error of .543%. Results for deflection were found same in both analytical and ANSYS.

Dynamic Analysis

The load which varies in magnitude direction or point of application with respect of time is called Dynamic load. In analytical analysis for load distribution contact ratio was calculated as 1.64 which was taken approximately 2. Time step for 40 nodes was calculated 0.0000925. In ANSYS analysis modelling of gear was done in Catia. In end results displacement and stress were expressed by using graphs obtained through analysis by ANSYS.

In conclusion author stated that maximum stresses occur in root of gear. Beam element more suitable for static analysis of spur gear. FEM model is good enough for dynamic stress consideration.

Conclusion

- Surface roughness and hardness factor can be change with the help of changing feed rate and cutting speeds
- Stresses on spur gear teeth can be change with change in contact ratio.
- Composite material can be use for manufacturing spur gear to change them with current cast steel spur gears for better results.
- Maximum stresses in gear occurs in root of gear tooth.

References

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