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Design and Analysis of Bearing Assembly and Gear Shaft for Milling Machine

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Abstract

The main objective of this project is design and analysis of gear, shaft and bearing assembly which is used to transmit power. Power is transmitted from the prime movers to a machine, from one machine to another, or from one member of a machine to another by means of intermediate mechanisms called drives. The most common are rotary motion drives. The gear shaft bearing assembly is one type of mechanical drive. For designing drives we need to know, Power to be transmitted from the driving shaft or the transmitted power on the driven shaft, Angular velocities of the driving and driven shafts, Distance between the shafts and their mutual location and Overall dimensions. For the above conditions, may drives of various types can be designed. The most advantageous design should be selected after the comparison of parameters like efficiency, weight, size, capital cost and operational and maintenance cost

1. Introduction

The main objective of this thesis is design and analysis of gear, shaft and bearing assembly which is used to transmit power. Power is transmitted from the prime movers to a machine, from one machine to another, or from one member of a machine to another by means of intermediate mechanisms called drives. The most common are rotary motion drives. The gear shaft bearing assembly is one type of mechanical drive. For designing drives we need to know, Power to be transmitted from the driving shaft or the transmitted power on the driven shaft, Angular velocities of the driving and driven shafts, Distance between the shafts and their mutual location and Overall dimensions. For the above conditions, may drives of various types can be designed. The most advantageous design should be selected after the comparison of parameters like efficiency, weight, size, capital cost and operational and maintenance cost. Shaft design calculations using classical techniques are reasonably straightforward for a shaft of

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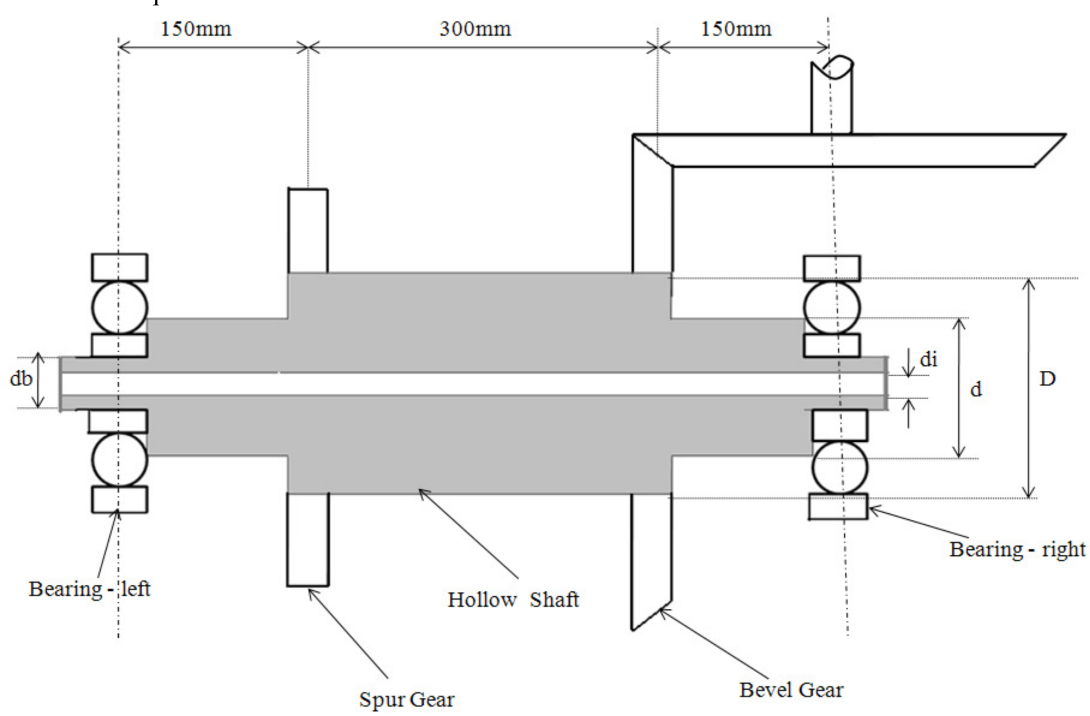
uniform diameter. Shafts with steps or shoulders for axial placement of gears, pulley, etc. make the calculation of shaft deflections significantly more difficult. FEA tools can handle complex geometries with little difficulty In research papers referred the researchers have dealt in improving capabilities of individual parts like gears, shaft and bearing by selecting improved materials in which composites have great contribution and by improving manufacturing process. These research works have helped in making efficient mechanical power transmission systems (drives). [2] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

2. Theoretical Analysis

1. From the given data and with suitable assumptions design SPUR and BEVEL Gears, considering (i) allowable stress (ii) Beam strength (iii) Dynamic load (iv) Endurance strength and (v) Wear load adhering to AGMA and other international standards .
2. Taking Gear forces and Bearing reaction forces[axial & radial] design hallow shaft assuming uniform cross section , considering combined bending and shear stress ,factor of safety and other relevant factors. Critical speed is to be found from Dunkerlys method.
3. Using values of theoretical calculation as reference values do FE analysis to achieve a better design of stepped shaft. Finally stepped shaft dimension is to be arrived after FE analysis.
4. Bearing is to be selected based on dynamic load required for bearing reaction force [axial & radial], required life and other requirement and relevant factors.



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3. FE Analysis

- **Linear static analysis:** FE model of stepped shaft is to be made using solid45 element by taking theoretically calculated diameter of shaft at critical cross section as reference. Linear static analysis of the shaft is to be carried out by considering bending moment and torque transmitted by the shaft (twisting moment). Linear displacement, angle of twist and various stresses are to be extracted. Final dimension of stepped shaft is to be arrived at after considering FOS, stress induced and displacement.
- **Modal analysis :** FE Model of Shaft and Bearing is to be made. Masses of Gears and damping ratio are to be considered for analysis. Undamped natural frequency and damped frequency of the system have to be found. Mode shapes have to be extracted.

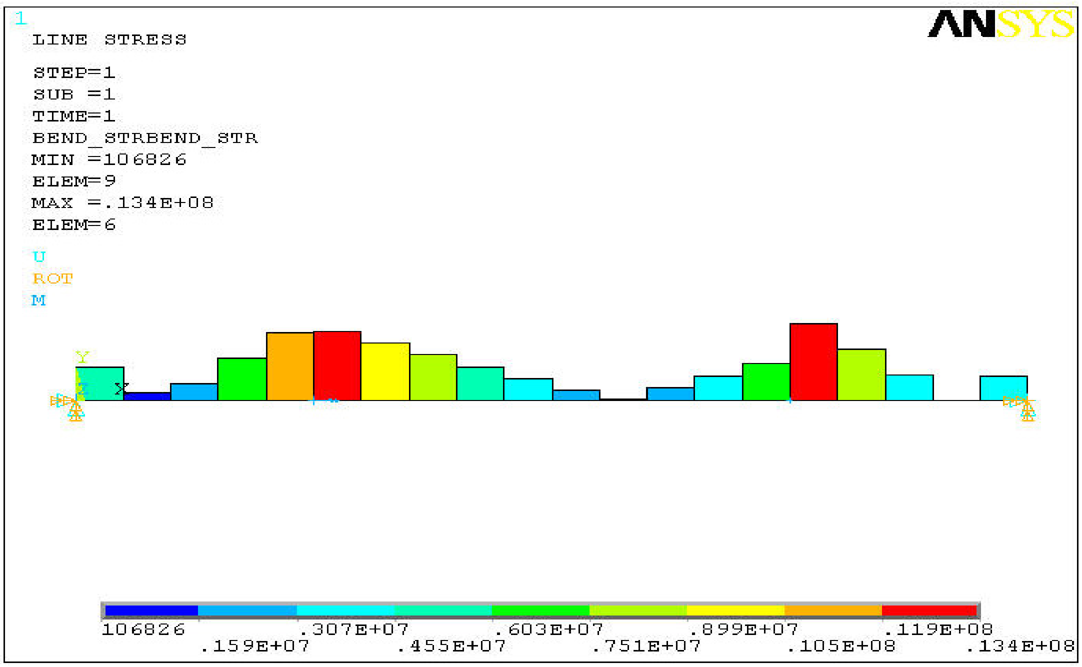

Figure Bending stress in Pa (N/m^2) due to direct bending.

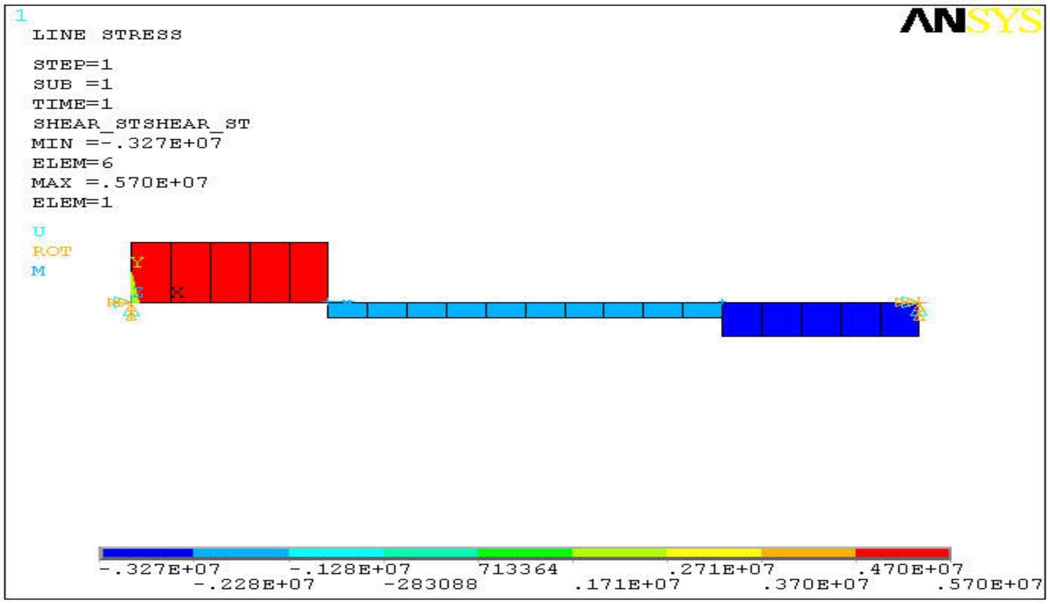

Figure Shear stress in Pa (N/m^2) due to torsion.

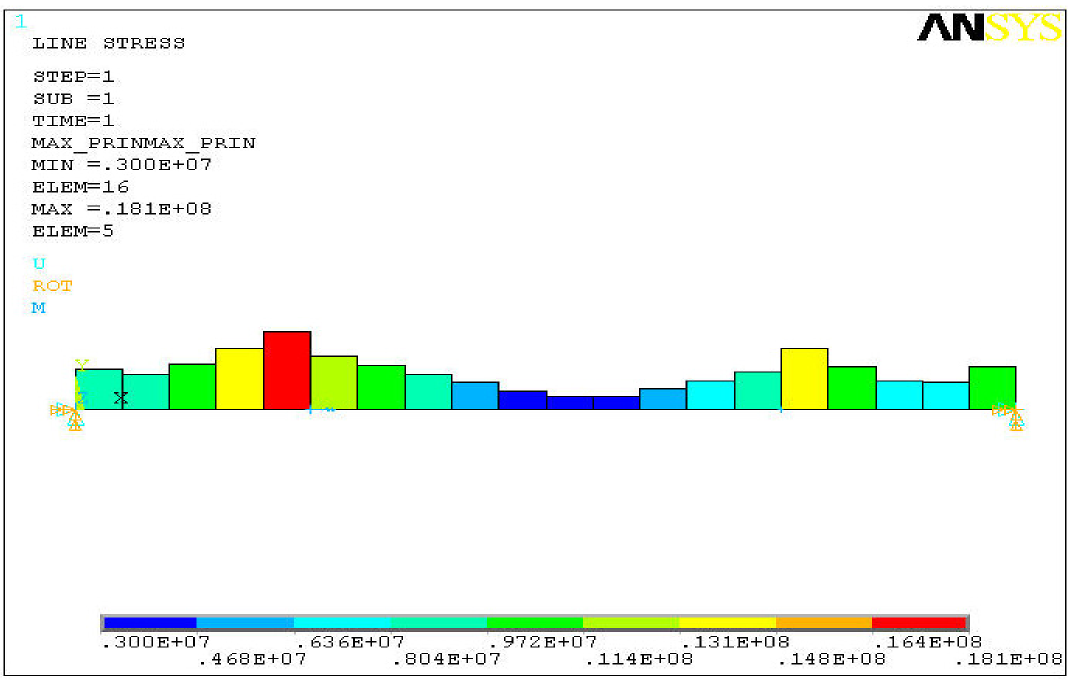

Figure 8.5 Combined stress (bending & torsion) in Pa.

4. Comparison of theoretical and FEA results for stresses induced in the shaft

Sl no	Stresses	Theoretical Results in MPa	FEA Results in MPa
1	Maximum bending stress due to bending load	16.80	13.40
2	Max shear stress due to torsion load	4.70	5.70
3	Maximum combined stress	18.02	18.1

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