

Design of Helical Gear Using MATLAB

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Abstract: Gear is a widely used mechanical component, whose primary use is to transmit power from one shaft to other. Gear drives are used to various kinds of machines like automobiles, metal cutting tools, material handling equipments, rolling mills, marine power plants etc. In this project we use a software called “MATLAB” to design gear. MATLAB is extensively used for scientific and research purposes. It is accurate and also has a number of built in functions which makes it versatile. In this project HELICAL GEARS are designed. The program is a user friendly one and when executed ask for the inputs like power to be transmitted, speed of the pinions, gear material, teeth on pinion, teeth on gear, helix angle etc, depending upon the gear selected, performs the necessary design calculations and output values like module, centre distance, tangential force etc. as output. As computers are used to perform the task of gear design becomes simple, friendly and error free.

Key words: Gear design • Helical gear • Bending and induced stress • Matlab

INRODUCTION

A Gear can be defined as the mechanical element used for transmitting power and rotary motion from one shaft to another by means of progressive engagement of projections called teeth. Gears use no intermediate link or connector and transmit the motion by direct contact. The two bodies have either a rolling or a sliding motion along the tangent at the point of contact. No motion is possible along the common normal as that will either break the contact or one body will tend to penetrate into the other. In the helical gears, the teeth are curved, each being helical in shape. Two mating gears have the same helix angle, but have teeth of opposite hands. At the beginning engagement, contact occurs only at the point of leading edge of the curved teeth. As, the gears rotate, the contact extends along a diagonal line across the teeth. Thus, the load application is gradual which results in low impact stresses and reduction in noise. Therefore, the helical gears can be used at higher velocities than spur gears and have greater load carrying capacity [1].

Classification of Gear:

- Parallel Axes-Spur gear, Helical gears, Herringbone gears and Internal gear

- Intersecting Axes gears-Bevel gears straight or spiral bevel
- Non-intersecting and Perpendicular Axes-Worm gear
- Non-intersecting-Non-parallel Axes gear-Crossed Helical gears



Gear Materials: Desirable properties for gear material are as follows:

- Endurance strength in bending to avoid bending failure.
- Surface endurance strength to avoid destructive pitting.
- Low coefficient of friction to avoid scoring.
- Low and consistent thermal distortion during heat treatment.

Heat Treatment: Gears can be through hardened or surface hardened.

Methods of Surface Hardening:

- Case Hardening
- Nitriding
- Flame Hardening
- Induction Hardening
- Carbo nitriding

Helical Gear: Helical gear is a cylindrical shaped gear with helicoids teeth. Helical gears operate with less noise and vibration than spur gears. At any time, the load on helical gears is distributed over several teeth, resulting in reduced wear. Due to their angular cut, teeth meshing results in thrust loads along the gear shaft. This action requires thrust bearings to absorb the thrust load and maintain gear alignment. They are widely used in industry [2].

Gear Parameter Used:

- Gear Type: Standard involute teeth
- Material: Alloy steel 40 Ni2 Cr1 Mo28
- Modulus of Elasticity: 2.1×10^5 N/mm²
- Module: - 3
- Helix angle = 15°
- Gear ratio = 4.25
- Power = 40kw

Design Stresses:

$$[\sigma_b] = \frac{1.4K_{bl}}{nK\sigma} \sigma_{-1}$$

Where, $\sigma_{-1} = 0.35\sigma_u + 120$

Centre Distance:

$$a \geq (i+1) \sqrt[3]{\left[\frac{0.7}{\sigma_c}\right]^2 \frac{E[M_t]}{i\phi}}$$

Where M_t = transverse module = $[M_t] = k_o, k_k, M_t$

k_k = load factor

Induced Stresses;

$$\sigma_b = \frac{0.7(i+1)[M_t]}{abm_{nv}}$$

$$\sigma_c = 0.7 \frac{i+1}{a} \sqrt{\frac{i+1}{ib}} E[M_t]$$

Advantage of Helical Gear:

Silent Operation: In a helical gear train, the teeth engage a little at a time rather than the entire face at once. This causes less noisy power transfer in case of helical gears [3].

Non-parallel Shaft: Helical gears can be used for transferring power between non parallel shafts. Though you have to compromise on efficiency in this case.

Strength: For same tooth size (module) and equivalent width, helical gears can handle more load than spur gears because the helical gear tooth is effectively larger since it is diagonally positioned.

Disadvantage of Helical Gear: A disadvantage of helical gear is the resultant thrust along the axis of the gear, which needs to be accommodated by appropriate thrust bearings [4-6]. This can be overcome by the use of double helical gears by having teeth with a 'v' shape.

Applications of Helical Gear: Helical gears are highly used in transmission because they are quieter even at higher speed and are durable. The other possible applications of helical gears are in

- Textile industry
- Blowers
- Feeders
- Rubber and plastic industry
- Sand mullers
- Sugar industry
- Rolling mills

Matlab: MATLAB (MATrix LABoratory) is an interactive system for matrix-based computation, designed for scientific and engineering use. MATLAB is a high performance language for technical computing. It integrates computation, visualization and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notations. Typically uses include:

- Math and computation
- Algorithm development
- Modeling, simulation and prototyping
- Data analyzing, exploration and visualization
- Scientific and engineering graphics
- Application development including graphical user interface building

MATLAB is a software package for high-performance numerical computation and visualization. It provides an interactive environment with hundreds of built-in functions for technical computation, graphics and animation. Best of all, it also provides easy extensibility with its own high-level programming language. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows solving many technical computing problems especially those with matrix and vectoring foundation.

Matrix Operators

Matlab Has Several Operators for Our Use:

- + addition
- - subtraction
- * matrix multiplication
- / division
- ^ exponentiation
- .* term-by-term multiplication
- ./ term-by term division
- .^ term-by term exponentiation
- >> MATLAB prompt

Programming in Matlab

Script and Functions: In MATLAB the programs are written in M-files are ordinary ASCII text files written in MATLAB's languages. They are called M-files because they must have a 'm' at the end of their name M-files can be created using any editor or word processing applications.

Script Files: Script files simply execute a series of commands when involved in MATLAB they do not involve the passing of variables script files are useful for a variety of things such as problem solving and data analysis. Script files are also useful for entering a long series of commands that may need correction.

Functions Files: A function file also like an m-file, like a script file, except that the variables in a function file are local function files are like programs or subroutine in Fortran, procedures in Pascal and functions in C. a function file is a self-contained block of statement that perform a coherent task of same kind.

CONCLUSION

The analytical outputs for the Helical Gear were obtained by using Matlab software and the given outputs also suggest that the designed Helical Gear was either safe or weak against wear.

The required design parameter for the Helical Gear obtained by the manual calculation [7-10].

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