

Design of spur gear transmission



This section outlines a design guidelines for iterating design process from which We can select an optimum design for given conditions.



In designs involving gear drives, normally the required speeds of rotation of the pinion and the gear and the amount of power that the drive must transmit are known. These factors determined from the application. Also, the environment and operating conditions to which the drive will be subjected must be understood. It is particularly important to know the type of driving device and the driven machine, in order to judge the proper value for the application factor.



The designer must decide the type of gears to use (spur gear, helical gear, bevel gear, worm and worm gear,); the arrangement of the gears their shafts; the materials of the gears, including their heat treatment; and the geometry of the gears: numbers of teeth, diametral pitch, pitch diameters, tooth form, face width, quality numbers.



The design procedure accounts for the bending fatigue strength of the gear teeth and the pitting resistance, called surface durability. This procedure makes extensive use of the design equations and of the tables, as well as , charts of design factors

You should understand that there is no one best solution to a gear design problem, several good designs are possible. Your judgment and creativity and the specific requirements of the application will greatly affect the final design selected. But as a beginner, try to work hard to create a reasonable design



Design objectives

Some overall objectives of a design are listed below.
The resulting drive should

- ◆ Be compact and small
- ◆ Operate smoothly and quietly
- ◆ Have long life .
- ◆ Be low in cost
- ◆ Be easy to manufacture
- ◆ Be compatible with the other elements in the machine, such as bearings, shafts, the housing, the driver, and the driven machine



Design procedure

1. Propose geometric size such as center distance from required velocity and application limitation
2. Choose the type of material
3. Choose A trial diametral pitch
4. Determined the load, face with, and other design factors
5. Compute bending stress, compare it with the allowable bending stress, if a reasonable value results, go to next step. Otherwise, a new pitch or revised geometry is selected.
6. Compute contact stress, analysis by same way for the surface durability.
7. The final specification of the materials for the gear are made to satisfy the requirement of both bending strength and pitting resistance

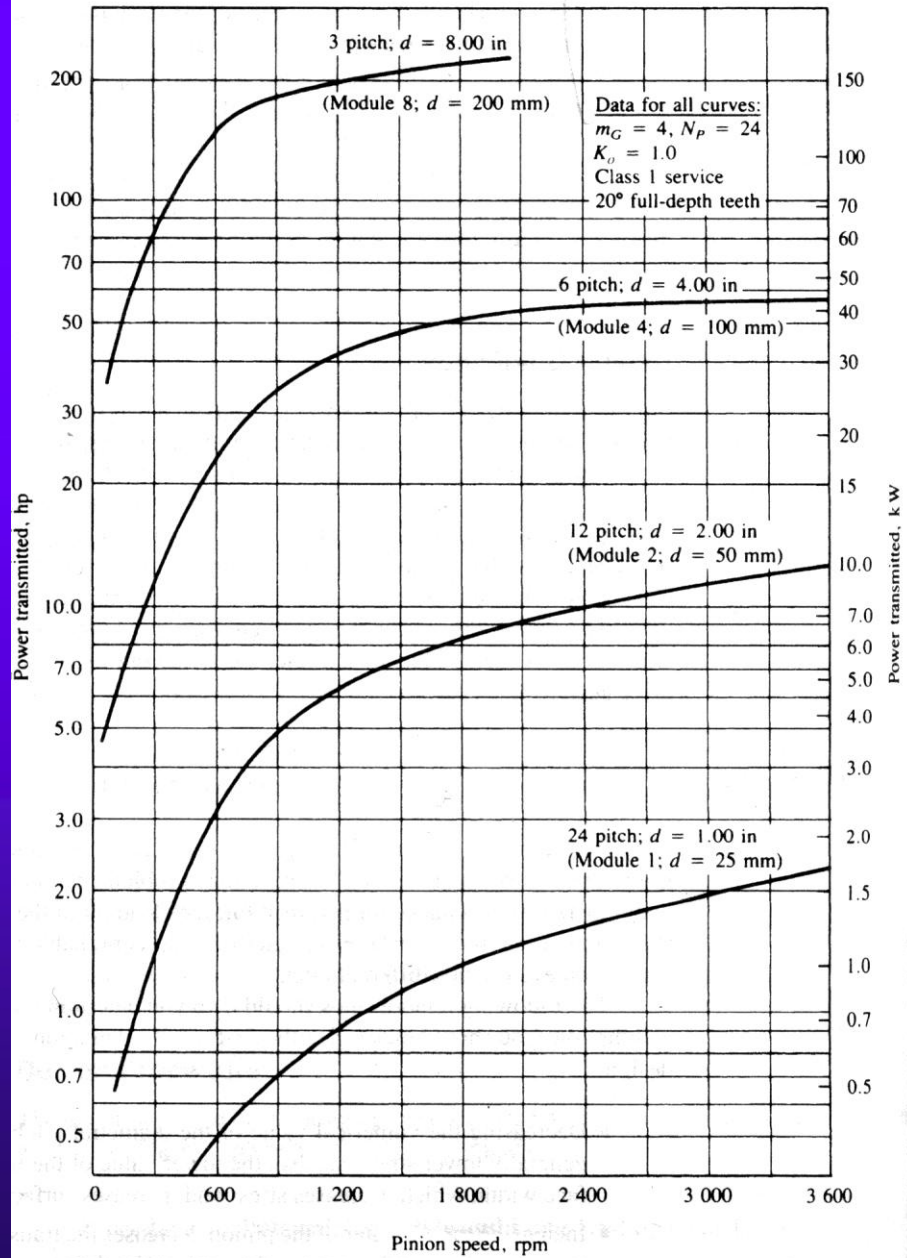


Design guidelines

- ◆ Chosen the diametral pitch

Use the graph of power capacity of a pair of steel gears versus the speed of rotation of the pinion, with several values of diametral pitch shown. The hardnesses for the pinion and the gear used for these curves are in the middle range of possible values for steel (approximately HB 300).

Note that the curves assume a uniform load and good alignment. If your application has higher values for either factor, the entire set of curves is shifted downward.





- **Determine the face width**

The face width, F can be specified once the diametral pitch is chosen. through a wide range of face widths is possible, the following limits are used for general machine:

$$8/Pd < F < 16/pd$$

Nominal Value of $F = 12/pd$

Also, the face width normally is not greater than the pitch diameter of the pinion.



Get a optimum design

- ◆ Decreasing the numerical value of the diametral pitch results in larger teeth and generally lower stresses. Also, the lower value of the pitch usually means a larger face width, which decreases stress and increases surface durability
- ◆ Increasing the diameter of the pinion decreases the transmitted load, generally lowers the stresses, and improves the surface durability
- ◆ Increasing the face width lowers the stress and improves the surface durability, but to a generally lesser extent than either the pitch or the pitch diameter changes discussed previously.



- ◆ Gears with more and smaller teeth tend to run more smoothly and quietly than gears with fewer and larger teeth.
- ◆ Standard values of diametral pitch should be used for ease of manufacture and lower cost
- ◆ Using high-alloy steels with high surface hardness results in the most compact system, but the cost is higher.
- ◆ Using very accurate gears (with ground or Shaved teeth) results in lower dynamic loads and consequently lower stresses and improved surface durability, but the cost is higher ,
- ◆ The number of teeth in the pinion Should generally be as small as possible to make the system compact. But there should be a undercut in the roof of teeth.



Example problem 9-5

A pair of spur gears with 20° , full-depth teeth is to be designed as a part of the drive for a wood chipper to cut pulpwood for use in a paper mill. The power source is an electric motor that drives the pinion at 1 750 rpm. The gear must rotate between 460 and 465 rpm. The gears must transmit 3.0 hp. A compact design is desired, but in no case can the center distance exceed 5.00 in.

Complete the design that will be safe with a fatigue life of greater than 10 million cycles. Specify the diametral pitch, the number of teeth in the pinion and the gear, the pitch diameters of the pinion and the gear, the face width, and the material with its heat treatment.