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DESIGN AND DEVELOPMENT OF GRAPHIC USER INTERFACE (GUI) FOR DESIGN OF SPUR GEAR USING COMPUTER PROGRAMMING TOOLS

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ABSTRACT

Gears are the backbone of the transmission system. There are different kinds of gears used in transmission systems and Spur Gears are one of the most basic elements in the system. The design process is iterative process and it takes a lot of time using the conventional process.Doing this manually is error prone and time-consuming process. This paper deals with design and development of a graphic user interface (GUI) for the design of spur gears. This GUI has three modules. Module 1 is developed for storing the material properties. Module 2 design the spur gear using input provided by designer and the module 3 generates the report (documentation) of the designed parameters for the spur gear.This GUI is developed using Visual Basic 6.0 as front end and M.S. Access as back end.

KEYWORDS: SPUR GEAR, VISUAL BASIC 6.0, MS-ACCESS, GUI

INTRODUCTION

Gearing is one of the oldest and most important critical components in a mechanical power transmission system. Spur Gears have straight teeth parallel to the axes and thus, are not subjected to axial thrust due to tooth load i.e. there tooth traces are straight-line generators of the reference cylinder. If the spur gears have external teeth on the outer surface of the cylinders, the shafts rotate in the opposite direction. In an internal spur gear, the teeth are formed on the inner surface of an annulus ring. An internal spur gear can mesh with an external pinion (small gear) only and the two shafts rotate in the same direction. The design process for spur gear involves a lot of time and iterations to arrive at suitable design parameters. The author has presented a GUI for design of spur sears to automate the design process of spur gear so as to reduce the time and error involved in the design phase. This GUI is developed using Visual Basic 6.0 [1] as front end and M.S. Access as back end [2].

LITERATURE REVIEW

Researchers are working from decades to develop the design of spur gears with the aid of computer programs. The web-based system for the design of spur gear was developed by Prasad D Yalla [3] and uses SI system of units as well as English system of units. The input data involves either the horsepower or torque at a particular gear, the materials for the pinion and gear, the operating centre distance, number of teeth on the pinion and gear, the pressure angle, face width, pinion RPM, operating temperature, module or diametral pitch. The outputs from the system are face width, clearance, backlash, Tooth deflection, circular pitch, interference and other required parameters. Savage, M., et al [4] worked for the optimal design of compact spur gear reductions. It includes the selection of bearing and shaft proportions in addition to the gear mesh parameters. Shuo et al [5] developed a computer-aided design system for generating bevel gears. The development was based on examining a perfectly plastic, cone-shaped gear blank rolling over a cutting tooth on a plane crown rack. The resulting impression on the plastic gear blank is the envelope of the cutting tooth. This impression and envelope thus form a conjugate tooth surface. Timothy R. Griffin [6] developed computer aided design software for torsional analysis. Dr. Veniamin et al [7] has presented a new approach based on the application of a special type of geometrical objects named blocking contours (BC) for the design of spur and helical gears. Based on the BC concept they developed computer aided design software for design of spur and helical gears. Božidar Rosić [8] presented the kinematics and computer aided procedure for the design of internal involute spur gears. A computer program was developed to design the gears for the

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given set of kinematics model. Ferreira B., Joseph [9] worked for the design of a system for cutting rudimentary spur gear on a laser cutter using some basic parameters of spur gear. The Laser Cutter quickly and accurately cut the outline of a gear from wood or plastic. The researchers are working in these directions so as to have automation in the design process.

CONVENTIONAL DESIGN PROCESS FOR SPUR GEAR

Gear tooth design involves primarily the determination of the proper pitch and face width for adequate strength, durability and economy of manufacture. The design approach used in this section is based on the choice of face width. The size is obtained by using iteration, because both transmitted load and velocity depend, directly on the module. The computation procedure is to select a trial value for the module and then to make the following successive computations [10]

1) The pitch diameter dp for pinion in mm is found from the below equation, where number of teeth (N) is estimated or given as minimum value and module is m.

$$d_p = \frac{2C}{1+VR} \qquad d_p = mN \tag{1}$$

For the desired center distance (C), where VR is velocity ratio;

$$V_{line} = \frac{\pi \cdot n_i\, d_p}{60000} \tag{2}$$

2) The pitch line velocity V_{line} in m/s is found from the below equation,

$$W_t = \frac{P \cdot \eta}{V_{line}} \tag{3}$$

Where n_i is pinion speed in rpm.

3) The transmitted load W_t in Newton is

(4)

$$K_v = \frac{6}{6+V_{line}}$$

where P is power in watt and η is mechanical efficiency.

4) The velocity factor (K_v) can be expressed for initial size calculation as,

(5)

$$F = \frac{W_t}{K_v\, m\, Y\, \sigma_p}$$

5) The face width F in mm based on permissible bending strength is found from the below equation, where σ_p is permissible bending stress.

$$F = \left(\frac{C_p}{S_H}\right)^2 \frac{W_{t,p}}{K_v\, d_p\, I} \tag{6}$$

The face width F, based on surface fatigue strength is

(7)

Where C_p is the elastic coefficient in MPa , $W_{t,p}$ is permissible tangential load and I as geometry factor for spur gears, and S_H is the surface strength in MPa.

GRAPHIC USER INTERFACE FOR SPUR GEAR DESIGN

The computer system for the design of spur gears has been created using the Visual Basic 6.0 programming language. This program is capable of designing the spur gear from the given input parameters like pitch circle diameter, velocity ratio, power or torque etc.

FRAMEWORK of GUI FOR DESIGN OF SPUR GEAR

The developed computer program consists of three basic modules and is accessed through a global user interface form. The framework of the forms within the developed system is depicted schematically in Figure 1.

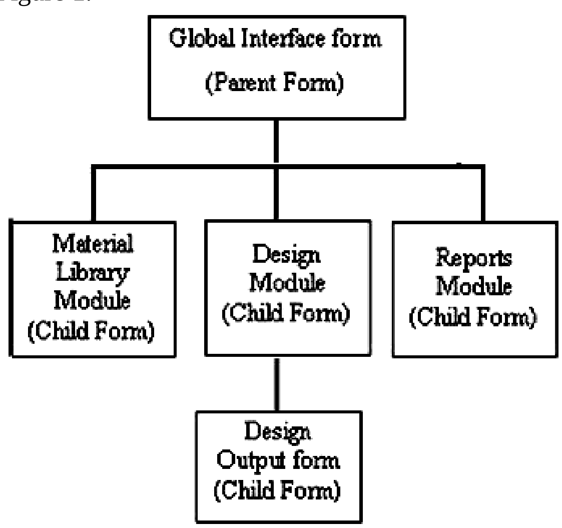

Figure 1: Schematic Diagram of Developed Software Framework

The global interface for the program is a parent form and is the main window for a program within which the other modules operate. The child forms, which include the Material Library, Spur Gear Design and Reports module, perform the specific tasks for which they are named. The Design Module contains one

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sub-module form of design output, which stores the successful design data. The database consists of material properties data and design data. These databases are connected to respective graphic user interfaces. The details of the parent form and the child forms within this program will be provided in the following sections. The whole of the computerized design process for spur gear is explained in the flowchart shown in Figure 2.

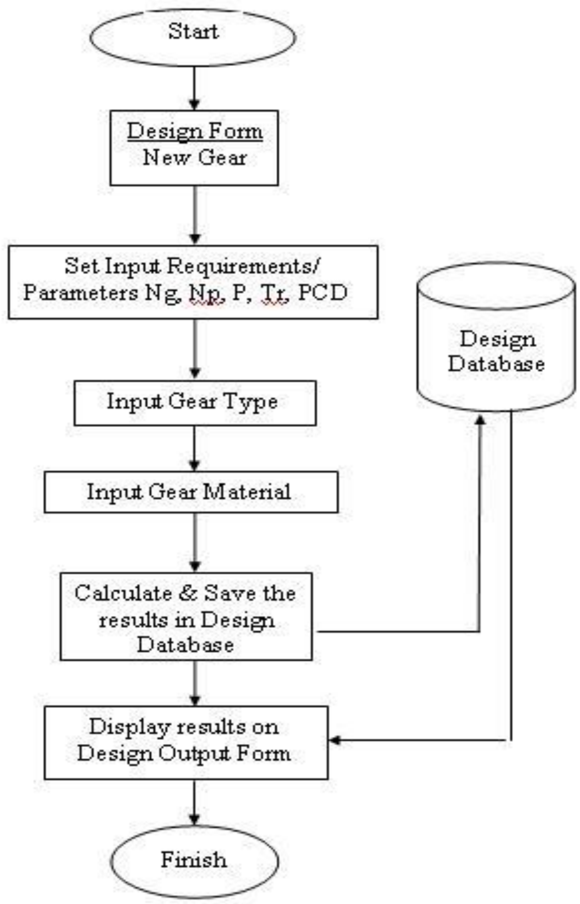

Figure 2: Design Process Flowchart

MATERIAL LIBRARY MODULE

This module is accessed when user clicks on the material library button of the tool bar within the global interface form. This module deals with the storing of the various materials and their properties of the spur gear. It contains two data-grid controls connected to material properties database. One data-grid control is used for pinion materials and other is for gear materials. The module is updateable, i.e. any new material and its properties can be added very easily by clicking on the add button of the gear or pinion section. The form is depicted in the Figure 3.

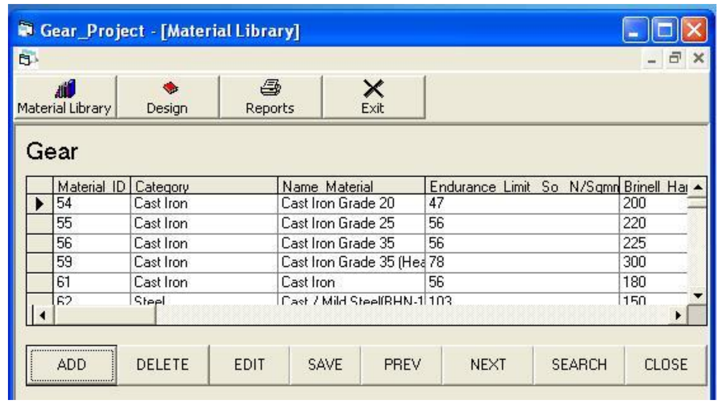

Figure 3: Material Library Module

DESIGN MODULE

This module is used for the design of the spur gear. The controls on this form are material selection, input / output parameters etc of spur gear as depicted in the Figure 4. The user has to enter the gear material, type and some of the given known parameters as input to the module. The other unknown parameters are than calculated using the developed computer program. To choose the quality of the spur gear a graph between module vs permissible error and permissible error vs pitch line velocity is also given in the form. This form has one child form for storing the design data in the database. This is used for storage of various designs data. The design output form is connected to the design data table of the database and is opened by clicking on the "Show Design Data" command button. Figure 5 shows this child form known as design-output form.

REPORT MODULE

This module form deals with the printing of the reports (documentation) of material and their properties and design data. This form is shown in the figure 6 and has two sections- Material and Design. Each section contains text box controls and command buttons to print the required type of document. Figure 7 shows the report forms of design data of spur gear.

RESULTS AND DISCUSSIONS

The Graphic User Interface for the design of spur gear is developed successfully. This is successfully implemented and it designs the spur gear for a given set of inputs as per the general procedure of design given in the various available literature. All the modules works as per their design. This GUI provides very easy interface for updating material properties, designing gear parameters on the basis of input and the generation of report of the gear parameters. The GUI is capable of generating the

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gear parameters for the various combinations of the input parameters.

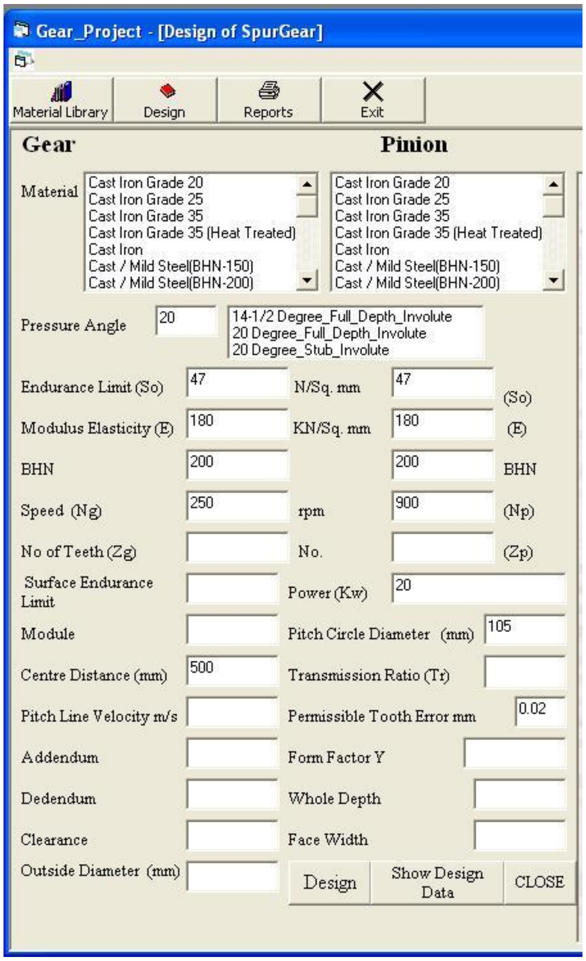

Figure 4: Design Module Form

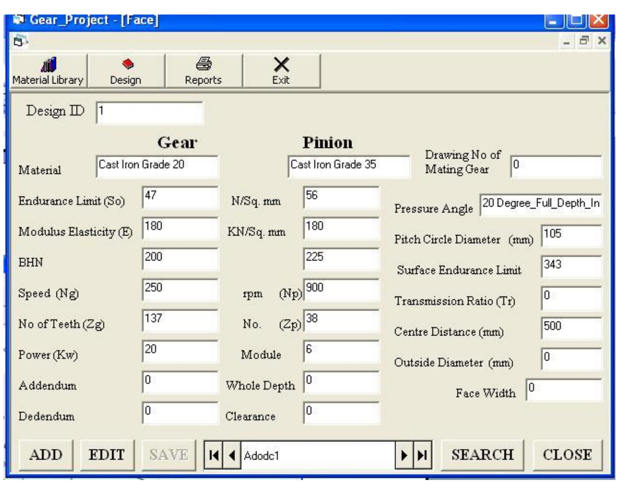

Figure 5: Design Output Form

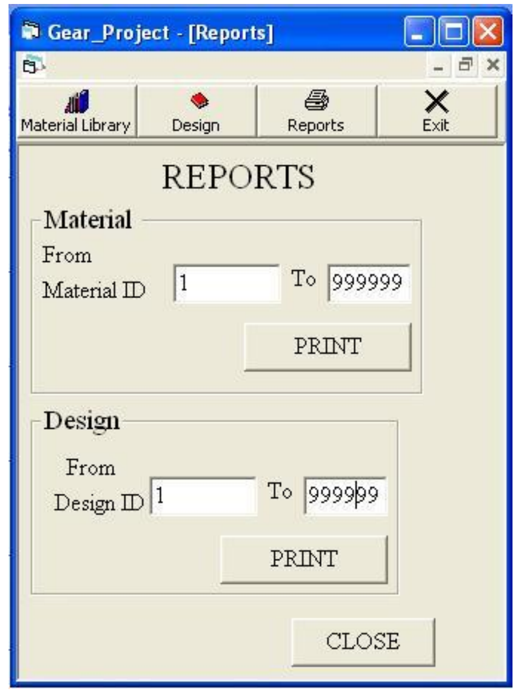

Figure 6: Report Module Form

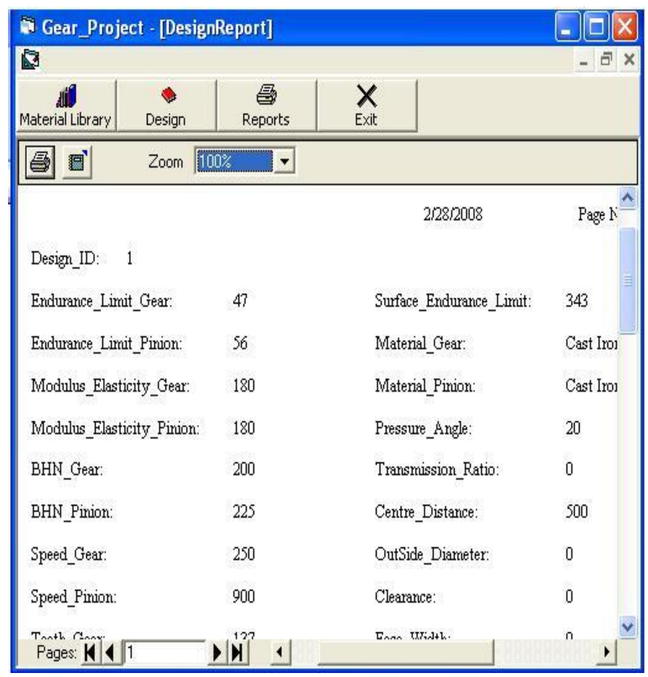

Figure 7: Design Report

CONCLUSION

A GUI based on the Computer programming language Visual basic 6.0 and MS Access has been developed for the design of spur gears. The GUI developed can be applied to gear industries making spur gear. The developed GUI is powerful, simple,

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easy to access and user friendly, as it gives wider flexibility of using and updating the experience and knowledge of the gear designer. The approach for the design of spur gear is determining the face width as output parameter for given load, power or torque conditions as input parameters.

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