DESIGN OF A PROGRAM FOR CHECK AND CALCULATION OF BELT GEARS

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The paper deals with the design of a program for calculation of belt gears. The aim of the presented paper is to create the program for check and calculation of belt gears and consequent comparison of the results of the newly created program with the existing ones. The introductory part of the paper analyses the issue of belt gears, their categorization as well as the design and calculation of the belt gears. The core of the paper focuses on the most frequently used software applied in the design and calculation of belt gears. The summary describes the design regarding the calculation of the belt gears and final comparison of calculations.

KEYWORDS
belt gear, design, calculation, program

1 INTRODUCTION

The drives represent the most significant parts of machines transferring kinematic and force effects from a driving motor to a working tool. It usually consists of several components which are interconnected and exposed to considerable stress. The components are frequently overloaded and thus the machine is extensively worn and damaged. Consequently, such machine is put out of operation. Therefore selection of appropriate layout of drive and correct design of its individual components represent a principal precondition to achieve reliable, safe, and economic machine operation [Mascenik 2011].

One of the aims of the paper is to clarify the issue of belt gears and analyse some of the available softwares for the design and calculation of belt gears. The main aim is to design the program for the calculation of parameters inevitable for the belt gear design [Bicejova 2016a]. The market offers wide assortment of belts and therefore correct specification of conditions of machine operation under which the gears shall be used is rather important. Currently, V-belts and toothed belts are quite often employed.

The introduction of the presented paper explains the issue of the design and check of the mechanical belt gears by means of the available softwares. The following programs were selected: MechSoft, Autodesk Inventor, MITCalc and ContiTech Suite. The main aim of the paper is to present a newly designed program for the design and control of mechanical gears, particularly of belt gears along with the new program design. The designed program was developed in the programming language C# by means of the programming tool Visual Studio Community which is the most commonly employed in creation of database programs. The chapter also contains information on selected programming tool and on properties of language C#, on starting the designed program, on selection of calculation method and on displaying of the calculation results in the designed program.

2 ANALYSIS OF AVAILABLE SOFTWARES FOR DESIGN OF BELT GEARS

MechSoft Program
MechSoft containing over fifty detailed engineering calculations. For instance, the calculation of gears of front and conical toothing, calculation of gears by means of the V-belt, by means of the toothed belt or chain, calculation of a fold joint, calculation of a joint by a key, check of a joint by welding, calculation of springs, calculation of bearings, check and design and calculation of shafts, design and calculation of cams, check and calculation of supports, etc. [Bicejova 2016b]

The calculation outputs can be represented by parametric models and all calculated objects occurring in the drawings contain complete information on calculation thus anytime the object can be altered and functional bonds among objects could be formed. MechSoft comprises a detailed engineering manual in electronic form with further structural information and basic data.

![Program MechSoft](image)

Figure 1. Program MechSoft

Calculation of Gear with the V-belts and with the Toothed Belts
One of the program modules is intended for calculation of transfer by the V-belts with standard sections as well as by the V-belts of narrow sections. The program allows complete designing and calculation of the belt gear. In fact, two types of calculation can be performed as follows:

- design - it designs the belt type meeting required properties of the gear.
- strength - it calculates strength check of the selected belt type [Mascenik 2012].

Autodesk Inventor Program
The program of Autodesk Inventor contains complex tools for generation of exact structural and manufacturing documentation directly off the 3D model. It includes the tools for design on the basis of rules and automation of standard tasks which facilitate the work and allow the users to concentrate on the structural aim instead of manual modelling of geometry. Autodesk Inventor captures functional requirements of the design and employs them in automatic creation of intelligent components and acceleration of the individual design phases. It helps:

- define complex configurations of products,
- increase development productivity,
- optimize designs [Balazikova 2016].

The program allows creation and analysis of the entire product prior to its production. At the same time the program enables to make use of advantages of the digital prototyping by the integration of the 2D drawings from application of Autodesk AutoCAD and 3D data into a single digital model [Bicejova 2016b].
The digital model creates virtual illustration of the final product and assists the companies with better designing, visualisation and simulation of the product. Relying on costly physical prototypes is thus avoided. It also helps launch the products more quickly and reinforces their competitive advantage [Salokyova 2016c].

The program solves the following tasks:
- calculation of 2 or 3 belt pulleys,
- automatic design of gears with minimal number of inputs,
- design and calculation of geometrical parameters (diameters of belt pulleys, axial distances, belt length, weight of gear),
- calculation of strength parameters (performance transferred by the belt, number of belts),
- calculation of force ratios (pre-stress, axial loading of belt pulleys),
- support of the 2D and 3D CAD systems [Bicejova 2013a].

The program cooperates with the CAD systems and contains the respective models of belt pulleys and belts. The calculations employ the procedures, algorithms and data of the ANSI, RMA (Rubber Manufacturers Association), ISO, DIN, BS documents and standards and of the basic documents from the catalogues of the company CONTITECH R [Mascenik 2014a,b].

ContiTech Suite Program
The CONTITECH SUITE calculation program represents a professional tool for the design of belt gears. The basic advantages are as follows:
- provides tabular user environment,
- allows design of drives within short period of time,
- allows complete solution of the design including the protocol on results and graphical representation.

The program allows fast and reliable solving of the calculations of any of the common types and kinds of belts such as:
- toothed belts,
- V-belts,
- grooved belts,
- multiple V-belts [Mascenik 2014].

The calculation results with all details can be saved, printed and sent in the PDF format by via e-mail.

One of the modules of the MitCalc program is also a module for the V-belts. The calculation is intended for both geometrical and strength design of the belt gears by V-belts.
The application is started by clicking on the 'Program Start' button. The main window appears with some of the pre-set values. According to program logic of Visual Studio the development is possible to employ the project templates the task of which is to assure that a programmer does not need to generate gradually all of the source files necessary for the project. The design of the presented application was generated in this development environment with the application of the WPF technology. In case of such designed type the language XAML is used in a high degree. The user interface is designed to be tabular and intuitive. The emphasis is put especially on balanced ratio between interactivity and simple control.

Properties of the C#:
- each category can be a descendant of a single category only and multiple inheritance is absent,
- global variables are absent, functions as well as methods must declared within the category at all times. Yet static variables and methods can be used instead which are implemented into a public category,
- declaration order of methods is not significant in the C# language,
- the C# language distinguishes between small and capital letters and is “case sensitive” [Krenicky 2011, Murcinkova 2013].

The user interface is designed to be tabular and intuitive. The emphasis is put especially on balanced ratio between interactivity and simple control. The main application window is divided into six basic parts. Each of the parts contains several control or display elements. In the part “Calculation Method” the unpack menu offers three loading methods which influence the steps of individual calculations. Other part “Belt” contains two unpack elements by means of which the belt type and properties can be selected.

The most important part of the main application window is the part “Parameters”. The part contains the fields for entering the input data. According to program logic only few of the fields are active that must be filled and in the course of calculation the other are gradually activated. A few more “Help” buttons can be found here as well. To display the basic results the part “Results” is at disposal which shows the individual values during calculation. All fields in this part are inactive and thus they cannot be rewritten. The entire part with results is filled when the calculations have been completed. The bottom part of the window contains buttons by which the calculation is controlled or the results can be displayed continuously in a separate window. The upper left corner of the application contains the unpack menu for work with data and with the program window itself. In this part a new window can be opened for a separate calculation as well as actual calculation can be reset or saved in the .pdf or .xlsx format. The menu also offers possibility to display the information on application.

Program Start-up
The application is started by clicking on the icon of the generated program. When the program has been started, the main window appears with some of the pre-set values. It is the case of initial setting of the values for selection of the loading method in calculation and for selection of the V-belt type. In the initial setting the rolling buttons are active and thus their values can be changed during this stage of calculation. In part of application for the value entering there are three text fields active after start-up. Number and type of active fields is changed according to the setting of loading method. Due to emphasizing of the necessity of entering or modification of data the text fields are highlighted. [Mascenik 2016b]

Selection of Calculation Method
According to the type of task it is inevitable to opt for the loading method of the designed gear. Three possible loading types can be opted from the following:
- entered performance and revolutions and torque shall be calculated,
- entered torque and revolutions and performance shall be calculated,
- entered torque and performance and revolutions shall be calculated [Puskar 2013].

Display of Results
When the calculations have been completed, the results can be displayed as follows:
- display of results in a separate application window – option serves for detailed calculation result preview in the application window. The window with results shall be displayed after clicking on the button “Result Preview”.
- print in the .xlsx format – complete results can be exported to the file in the .xlsx format which can consequently be opened for instance by the Microsoft Excel program.
- print in the .pdf format – final results can also be exported to the .pdf format [Pavlenko 2016].

4 CONCLUSIONS
The main aim of the presented paper is to introduce a newly designed program for calculation of parameters inevitable for design and check of belt gear. The program was designed with the Visual Studio Community tool in the programming language C#. Considerable advantage of Visual Studio is possibility to control or display elements. In the part “Calculation Method” the emphasis is put especially on balanced ratio between interactivity and simple control. Calculation of the belt gears in the designed program is given by the individual steps which must be followed to achieve the most accurate result [Salokyova 2016b]. To verify the calculation results and usability of the designed application in practice, the data acquired from three sources were compared during designing of the program – i.e. through manual
calculation, by the MechSoft program and by the designed application. In the future the program could be extended by calculations of the toothed and of the flat belt gears as well as by calculations with more belt pulleys. Further program improvement could include automatic entering of tabular values into calculations or graphical representation of the designed gear.

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