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COMPUTER AIDED ENGINEERING AND DRAFTING OF BEVEL GEARS

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ABSTRACT
This paper deals with development of IT support to the process of designing, calculating and drafting of technical drawings of mechanical products. Using popular software development tools and finding principles and methods of their integration, a more effective CAE/CAD module has been developed in which, process of calculation of bevel gears and generation of its technical drawings are integrated, and the time needed for their creation is significantly reduced. The parametric models for a few particular constructive shapes of the bevel gears have been developed. This CAE/CAD module is meant to be a part of a modular CAE/CAD system for calculation and drafting of technical drawings of different machine elements.
Keywords: bevel gears, computer aided engineering, computer aided drafting

1. INTRODUCTION
There are a great number of CAx (Computer Aided) software offering a wide range of different capabilities and prices. The most of Cax software is generally oriented, but some of them are oriented to user from the field of mechanical, civil or electrical engineering, architecture and so on. Regarding the basic goal of CAx software application, which is increase of productivity of its users, an actual trend is development of CAx tools more orieneted to needs of different user groups. Therefore, this paper deals with solution of CAE/CAD system integrating calculation and drafting of technical drawings of bevel gears.

The idea for development of such a CAE/CAD system is based on needs of companies, such as Mine and thermo power plant Gacko, which use CAx tools mostly in its maintenance department. Mine and thermo power plant Gacko is company owning numerous machines, tools and equipments, which makes maintenance of vital importance for company functioning. Each sudden break down causes great expences. The machines and equipments are mostly produced by foreign companies which makes spare parts supply difficult. There are a few possibilities for spare parts supply:

1. From manufacturer which delivers original parts with high prices and long delivery terms;
2. From domestic suppliers which deliver spare parts, whose production is not based on original technical drawings but on damaged specimens, with lower proces and shorter delivery terms;
3. Repair or production of spare parts in company workshops in order to shorten duration of sudden break down of production process.

Design bureau as a part of maintenance departement of Mine and thermo power plant is alike most of small and midlle size design bureau in other thermoenergetic companies. The bureau engineers design different machine parts for current maintenance or general overhaul of thermoenergetic facilities. They often need to take measures from damaged od broken machine element such as gear, which is usually imposible and requires its precalculation in order to determine dimensions and to draft technical drawing needed for gear production. It is a longlasting process followed by numerous mistakes.

Conventional way of preparation of technical documentation based on calculation of machine elements and drafting of its technical drawing by hand, frequent incompleteness, nonstandardization, lack of adequat archiving and searching of technical documentation is obstacle for efficient maintenance system. From that reason implementation of CAx tools in all aspects of maintenanace system is a must which cause needs for development of specialized modular CAE/CAD system for calculation and drafting of technical drawings of machine elements. This system is to be consisted of independent modules whose development could be based on approach which is going to be introduced by the module for calculation and drafting of technical drawing of bevel gears.

2. METHOD

2.1 Choice of environment for development of CAE/CAD system for engineering and drafting of bevel gears

Database containing all needed data for calculation of bevel gears is designed in Microsoft Access database menagement system. Development of software application for calculation of bevel gears is realized within programming environment Embarcadero® Delphi® 2010 Version 14.0, which involves integrated tool for external database menagement Blackfish SQL Developer's. Drafting of technical drawings of bevel gears is realized by computer aided drafting software AutoCAD which involves integrated programming tool AutoLISP used to develope software application for automation of bevel gears drafting.

2.2 Calculation of carrying capacity of bevel gears

There are a few methods for determination of factors influencing carrying capacity of bevel gears [1]:

Method A: Factors are determined by measurements and/or detailed calculation followed by an analysis and simulation of system performances. To conduct this method one has to know all constructive and technological data on gearing, loads and exploitative conditions. Because of that this method is rarely used.

Method B: Factors are determined based od certain simplifications. For example, the pinion and the gear are supposed to be an oscilating system consisted of masses of the pinion and the gear neglecting the influence of other gears in the gearing box. This method gives satisfactory results.

Method C: Comapred to method B additional simplifications are taken into account when different factors are determined. For example, the pinion and the gear are supposed to work only within uncritical range of number of revolutions, the pressure anlge of the pinion and the gear is also supposed to be 20°, tolerances of pitch of pitch circle is the same as tolerances of pitch of any other meshing circle and so on.

Method D: Compared to method C additional simplifications are taken into account when different factors are determined. For example, unit load of the pinion and the gear is supposed to be constant and equel to 350 N/mm^2.

In this paper, which is most common approach, calculation of different influental factors is conducted according to method B i C, for approximate calculations the tabular values of some factors according to method D are also used. This calculation is introduced in detailes by Miltenović and Ognjanović [1].

A database, containing values of all parameters taking into account influences of different quantities on working and allowable stresses of tooth flank and rooth of the bevel gears, is developed in Microsoft Access environment. Database scheme is shown in Figure 1.

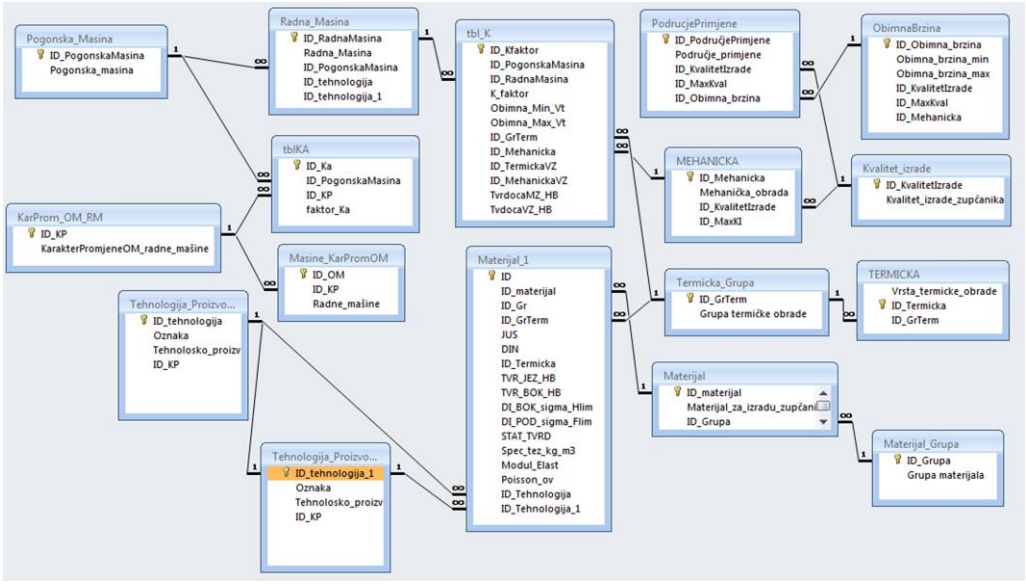

Figure 1. Database containing influental parameters of working and allowable stresses of bevel gear tooth flank and rooth

2.3 Choice of material, basic dimensions and constructive shape of bevel gears

Choice of material for bevel gears is conducted based on the folloving criteria:

- Tehnological and production requirements [2] after which materials are grouped depending on gearing load (low, meadium, fair, high, extremly high and high-speed gearings), production (single or serial), gear dimensions (small or big);
- Driving and driven machine [1] after which choice of material is based on experiance of numerous manufacturers of gearing transmission.

Afterwards precalculation of bevel gears is conducted after procedure explained in details in literature [1,2,3] in order to choose gear dimensions.

Constructive shapes of bevel gears are chosen in accordance with gears being part of plants of Mine and thermo power plant Gacko. Constructive shape of bevel gears being part of gearing transmission of reclaimer feeding mechanism for coal handling with all dimensions is shown in Figure 2.

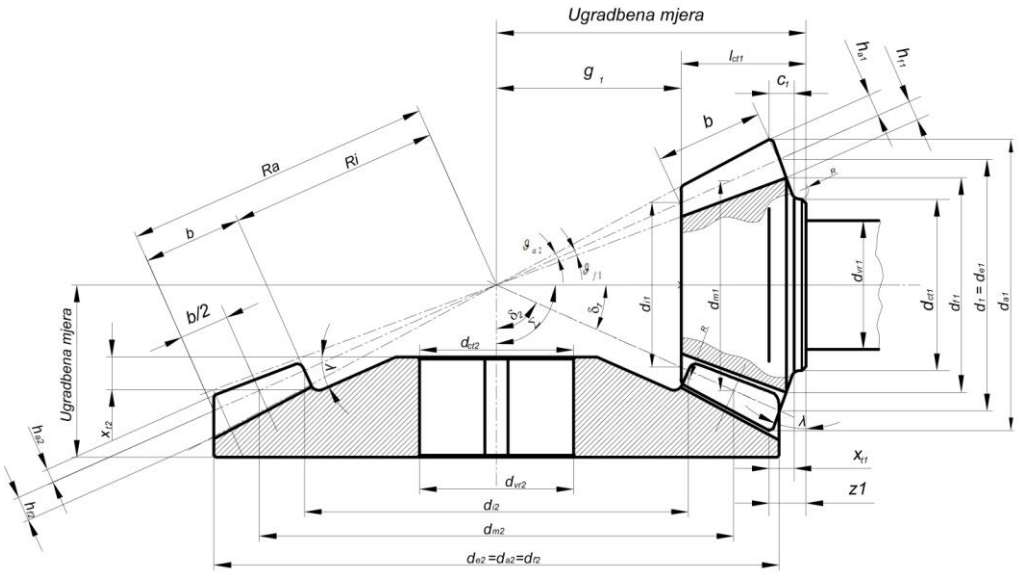

Figure 2. Bevel gears

3. RESULTS

A software application for calculation of bevel gears is developed within programming environment Embarcadero® Delphi® 2010 Version 14.0 based on previosly described procedure. Graphical user interface of developed software application is shown in Figure 3.

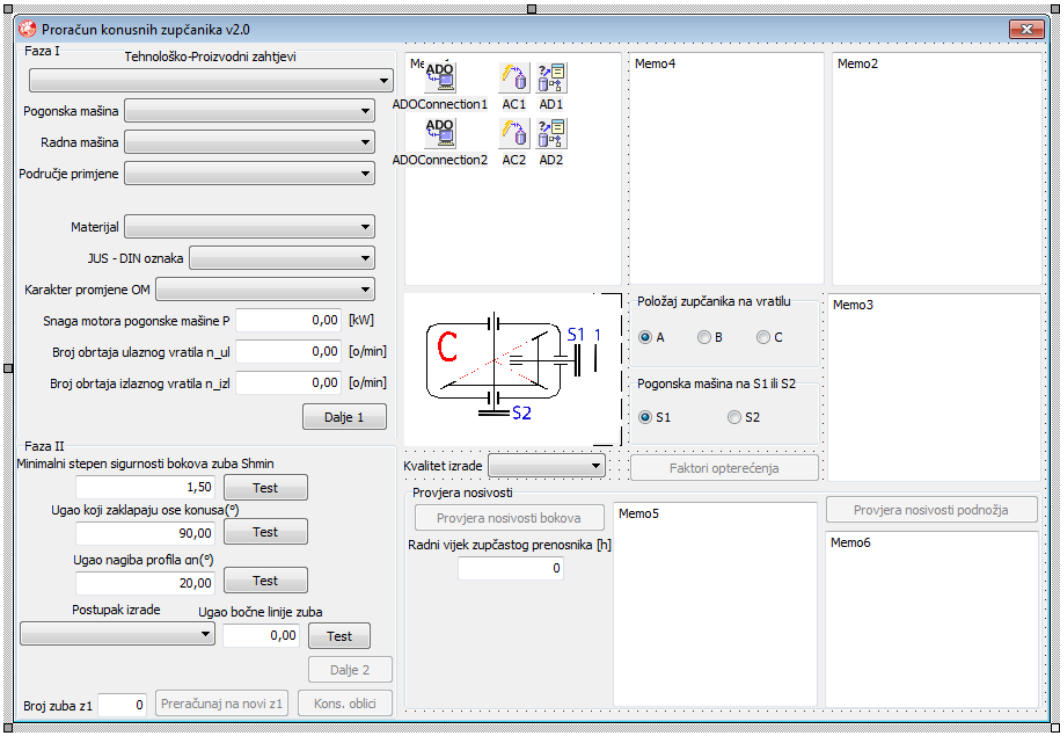

Figure 4. Graphical user interface of software application for calculation of bevel gears

Based on input data software application performs detailed calculation of bevel gears dimensions for chosen constructive shape. Obtained data are saved in ASCII file in order to use it for generation of technical drawingsof bevel gears. Automatic generation of technical drawings of bevel gears is realized within environment of comuter aided drafting software AutoCAD by means of software application developed by AutoLISP programming language.

4. CONCLUSION

Proposed approach of calculation and drafting of technical drawings of machin elements, explained in terms of example with bevel gears, influence considerably on increase of work efficiency of engineers in design bureau. Besides, use of CAx tools, which automatizes longlasting calculations, minimizes possibility of human errors and need for postcorrections of engineers work.

5. REFERENCES

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