



CALCULATION PROGRAM FOR ELASTIC COUPLINGS WITH BOLTS AND NON-METALLIC ELEMENTS

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Abstract: The paper presents a design program of new elastic couplings with normal bolts and non-metallic elements, in which the non-metallic element can have various constructive forms, which can be verified through the program. The novelty of this coupling consist in existence of a one disc between two semi coupling, of eight metallic plates, the nonmetallic elements from different qualities rubber that are mounted of bolts.

Keywords: elastic couplings, nonmetallic element, normal bolts, milled bolts, design program

1. INTRODUCTION

The elastic coupling with cylindrical bolts and nonmetallic elements are composing from semicouplings, intermediary disc, metallic plates, cylindrical pin of centered of a intermediary disc to the one semicoupling, milled bolts, screws of fixing of metallic plates to the intermediary disc, Grover washer, nuts and nonmetallic elements.

2. DESIGN PROGRAM FOR CALCULATION OF ELASTIC COUPLING WITH CYLINDRICAL BOLTS AND NON-METALLIC ELEMENTS ELASTIC

The paper presents a calculation program of new elastic couplings with bolts and non-metallic elements that allows the design of these couplings, sizing components, checking feathers, bolts and non-metallic elements and drawing diagrams using analytical relationships that are introduced in the program.

Elastic couplings with bolts and non-metallic elements transmit torque and rotational movement and dampen vibrations and shocks.

Figure 1 presents first window “Design data” of design program.

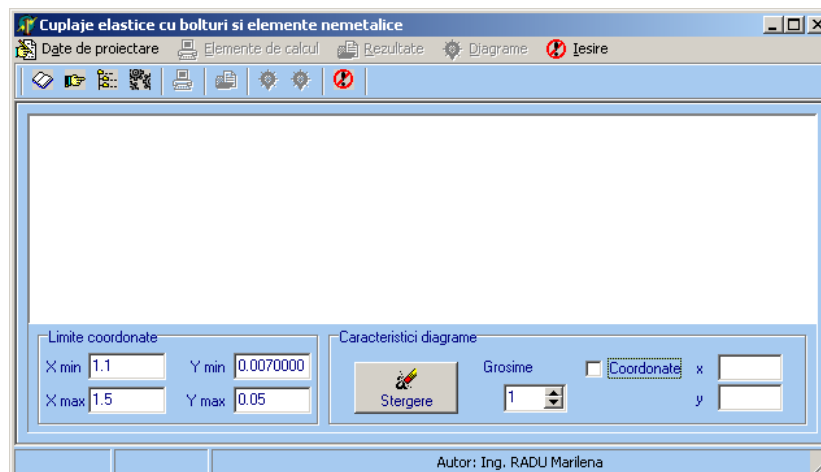










Figure 1. Window „Design dates “

Table 1: The windows of program

Menu	Submenu	Remarks
<i>Designing dates</i>	Technical data 	<ul style="list-style-type: none"> • It allows the input of the transmission power, the operating speed and the diameter of the input shaft of the motor machine.
	Operating conditions 	<ul style="list-style-type: none"> • It allows to establish the data regarding the motor machine, the character of the load, the choice of the constructive variant of the coupling.
	Used materials 	<ul style="list-style-type: none"> • Allows the choice of materials for the component elements of the chosen coupling variant.
	Results. Input data 	<ul style="list-style-type: none"> • It allows both the display of the results obtained as a result of the previously entered data, and the setting of the values of some constructive parameters.
<i>Calculation elements</i>		<ul style="list-style-type: none"> • It allows establishing the elements necessary for the crushing verification calculations between the bolt and the non-metallic element, the bending of the bolt, the determination of the force that loads a bolt.
<i>Results</i>		<ul style="list-style-type: none"> • Allows the display of results.
<i>Diagrams</i>		<ul style="list-style-type: none"> • Allows charting: • - $K_{F1} = f\left(\frac{h_1}{d_b}\right) = (0,1...0,007)\left(\frac{h_1}{d_b} - 1\right)$, $K_{F2} = f\left(\frac{h_2}{d_b}\right) = (0,1...0,007)\left(\frac{h_2}{d_b} - 1\right)$, • $K_{F3} = f\left(\frac{h_2}{d_b}\right) = (0,1...0,007)\left(\frac{h_2}{d_b} - 1\right)$. • - calculation torque depending on the relative rotation angle of the two half-couplings, $M_{tc} = M_{tc}(\varphi)$.
<i>Output</i>		<ul style="list-style-type: none"> • Allows the program to leave the shit.

The menus and submenus that the calculation program contains are summarized in Table 1 [1].

The interface of the program is designed so that the activation of the menus corresponding to the results is not possible until after entering the design data (figure 1).

The "Design data" menu (fig. 2) contains 4 submenus, activating them leading to the opening of 4 dialog boxes for entering the input data, as follows: "Design data. Technical data" window, fig. 3; the "Design data. Operating conditions" window - fig. 4; the "Design data. Choice of materials" window - fig. 5; the "Input data. Results" window - fig. 6.



Figure 2: "Design data" Window

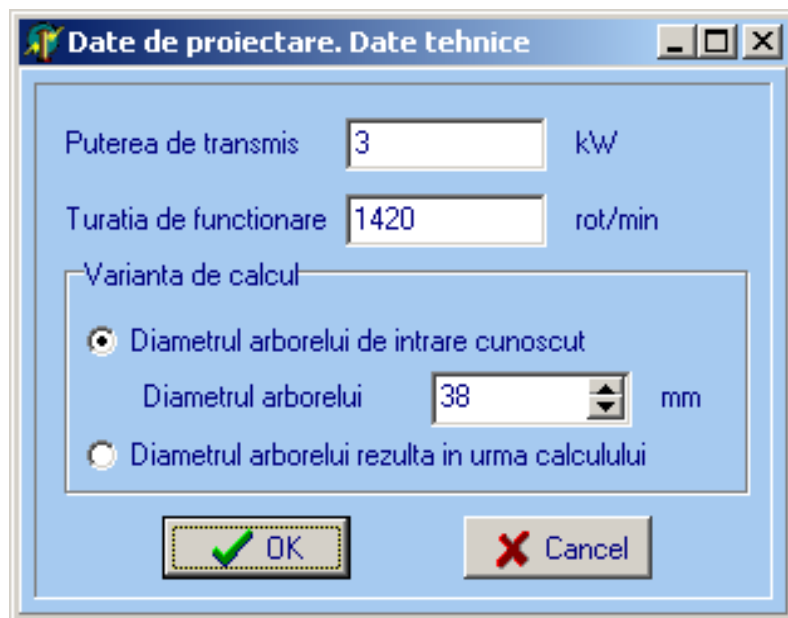


Figure 3: "Design data. Technical data" window

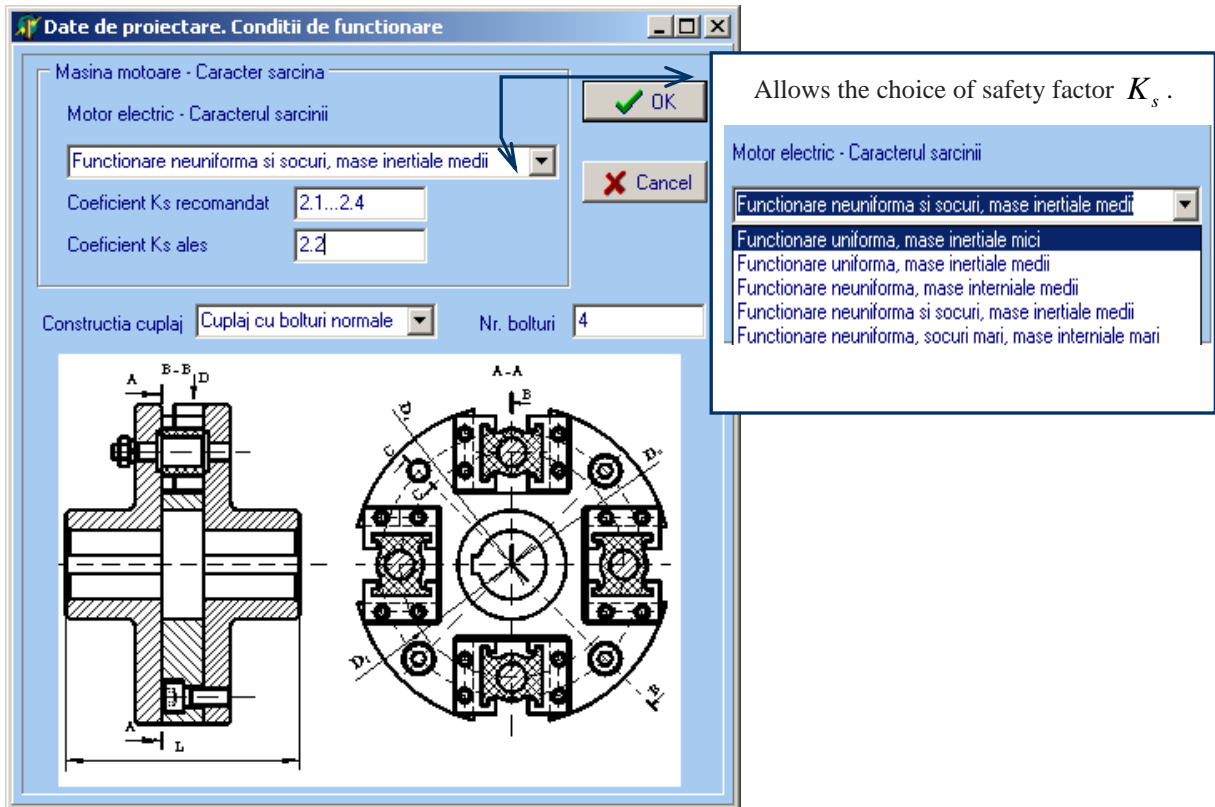
"Design data. Technical data" window (fig. 3) includes the main data regarding the transmission power, the operating speed of the coupling, as well as the calculation variants of the input shaft diameter. If the diameter of the shaft is known, then its value is entered. If the diameter of the shaft is not known, then the value of the diameter of the input shaft results from the calculation.

For example, in figure 3 the following input data were chosen: motor power $P = 3$ kW, motor speed $n = 1420$ rot/min and shaft diameter, $d = 38$ mm - considered known, on which the coupling is mounted.

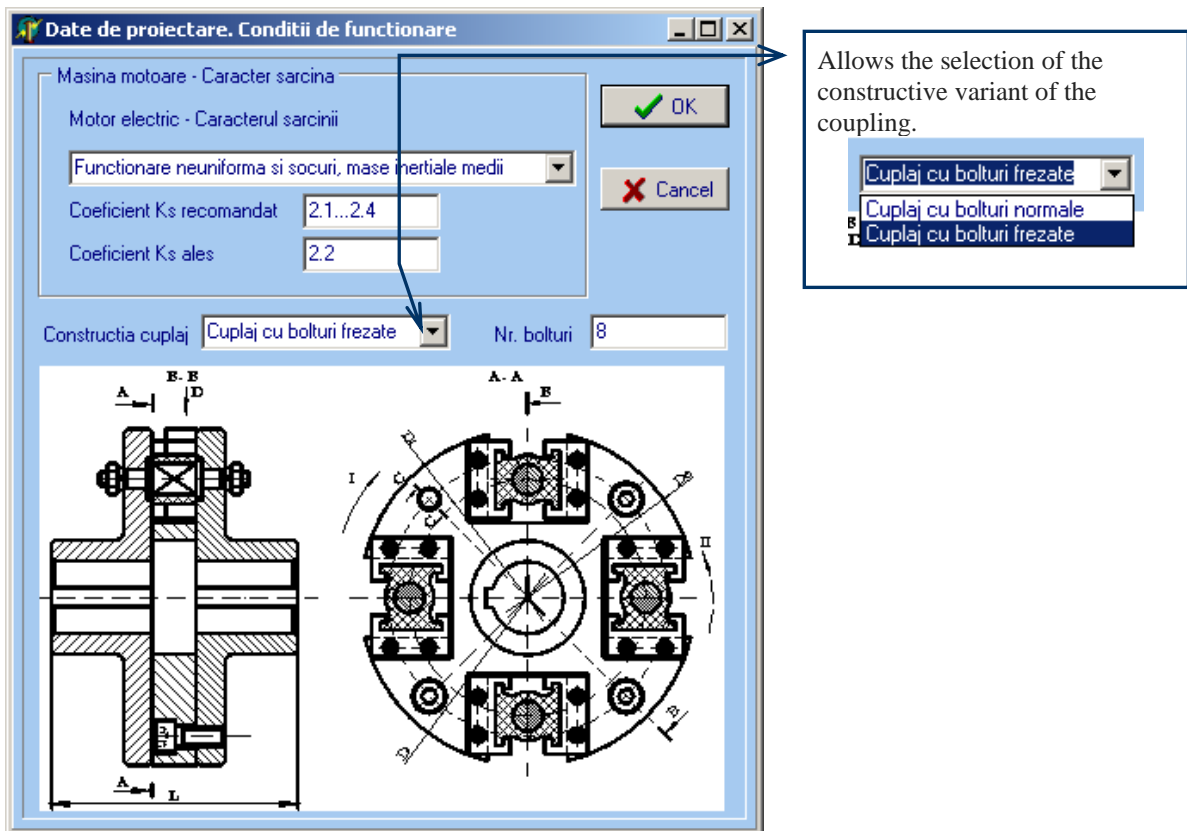
In the "Design data. Operating conditions" window (fig. 4) data are presented regarding the motor machine, load character, recommendations regarding the safety coefficient K_s depending on the load character, choice of the value of the safety coefficient K_s in the recommended interval, establishment of the constructive variant of the coupling.

From the window "Input data. Choice of materials" (fig. 5) the materials can be chosen for the component elements of the coupling (intermediate disc, plates, milled bolts, feather, semi-couplings, bolts and non-metallic elements).

For example, NR natural rubber was chosen for the non-metallic element.



a



b

Figure 4: Choice of safety factor K_s and selection of the constructive variant of the coupling

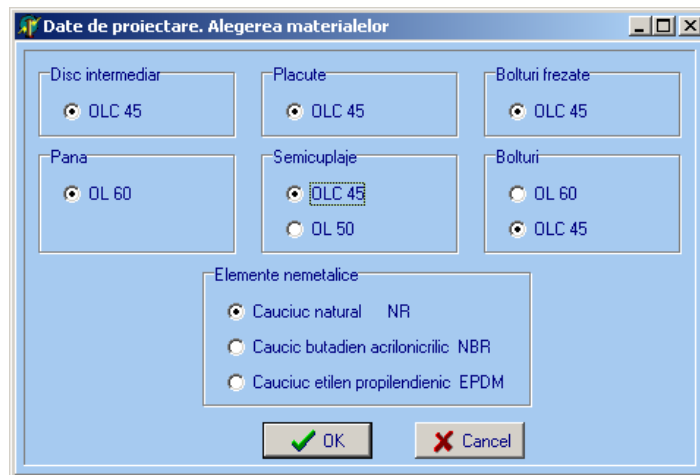


Figure 5: Choice of materials

From the window "Input data. Choice of materials" (fig. 5) the materials can be chosen for the component elements of the coupling (intermediate disc, plates, milled bolts, feather, semi-couplings, bolts and non-metallic elements).

For example, NR natural rubber was chosen for the non-metallic element.

In the "Input data. Results" window (fig. 6) the following partial results are displayed:

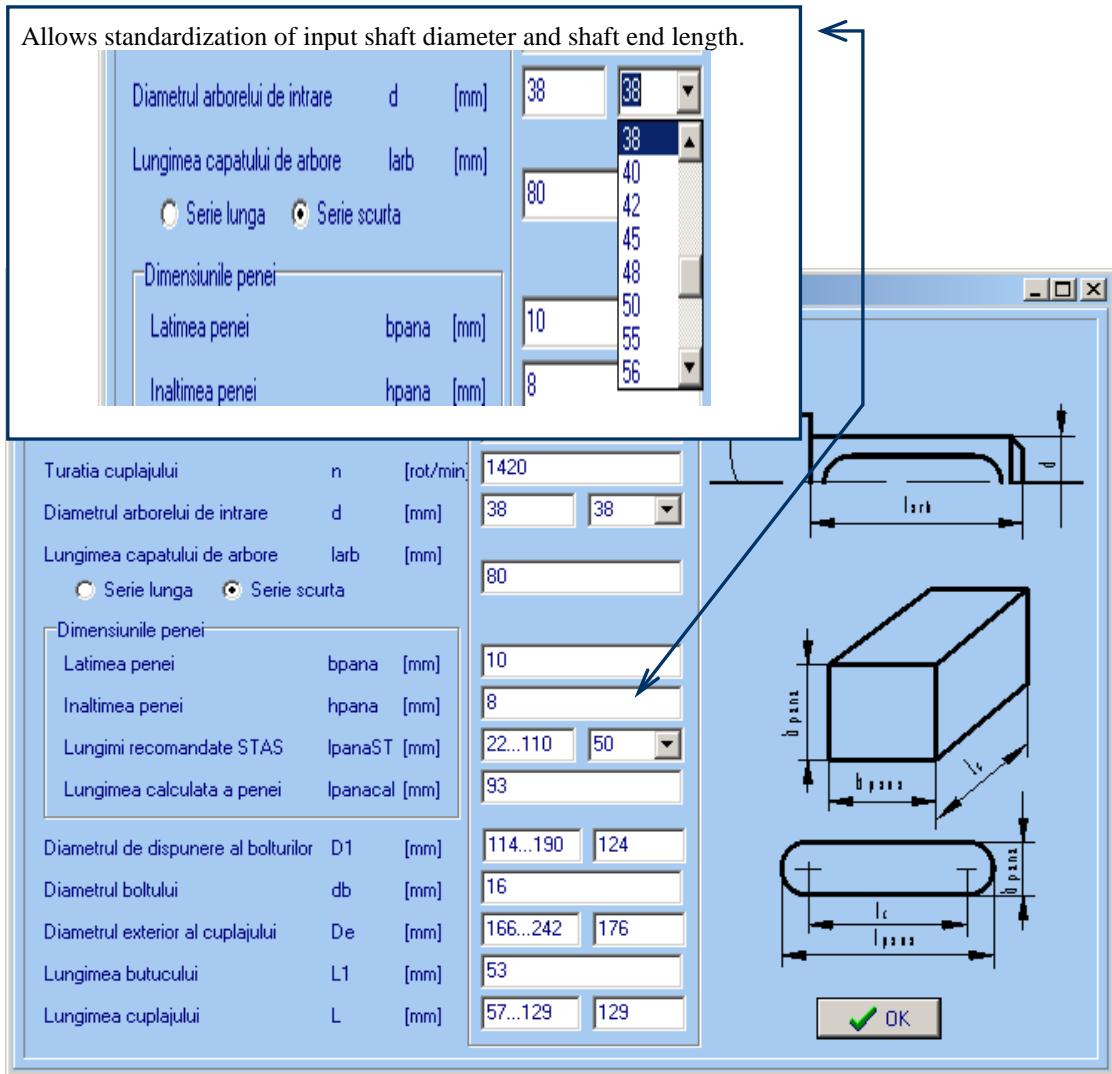
- the value of the nominal torque M_{tn} ;
- the value of the calculation torque M_{tc} ;
- speed, n , at the shaft on which the coupling is mounted;
- diameter of the input shaft d - known value / value resulting from the calculation, with the possibility of standardizing the displayed value for the shaft diameter;
- standardized length of the shaft end - depending on the series of the shaft (long, short);
- wedge dimensions (b_{pana} , h_{pana}), depending on the diameter of the shaft d ;
- lengths recommended in the STAS for the wedge, the real length of the wedge resulting from the calculation with the possibility of adopting a standardized length;
- establishing the value of the arrangement diameter of the bolts, D_1 , in the recommended interval;
- bolt diameter, d_b ;
- exterior diameter of the coupling, D_e ;
- hub length, L_1 ;
- the length of the coupling, L , with the possibility of choosing its value in the recommended interval.

It is also possible to set the values for the arrangement diameter, D_1 , of the bolts, the exterior diameter, D_e , of the coupling and of the coupling length, L .

The "Calculation elements" window (fig. 7) presents the calculation schemes for the two constructive variants, respectively the three constructive forms of the non-metallic element, giving the user the possibility to choose the desired shape for the non-metallic element, after which the program calculates and displays automatically the constructive dimensions of the selected shape. For example, the first construction form of the non-metallic element was chosen.

The "Results" window shows the final results obtained from the verification calculations performed inside the program, as can be seen in fig. 8. The following final results are displayed in this window:

- the force that loads a bolt;
- checking the chosen constructive form of the non-metallic element at the two stresses (traction, crushing) with the possibility to compare the effective tensile / crushing stresses with the admissible stresses corresponding to each stress;
- determining the capable torsion moments from the condition of resistance to traction, respectively to crushing;
- determining the ratio of capable torques;
- bending check of the bolt with the possibility of comparing the actual bending stress with the allowable stress corresponding to this request;
- determining the relative rotation angle between the two half-couplings, knowing the calculation torque;
- determination of the static rigidity of the coupling.



Allows standardization of feather length.

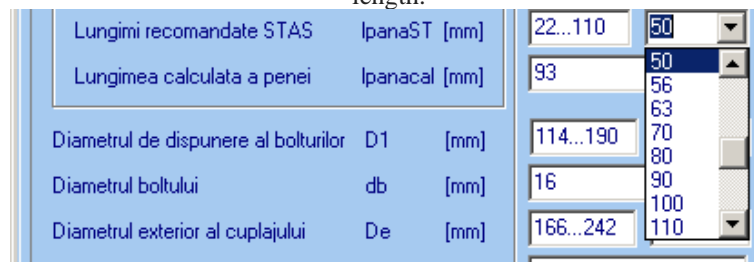


Figure 6: Partial results

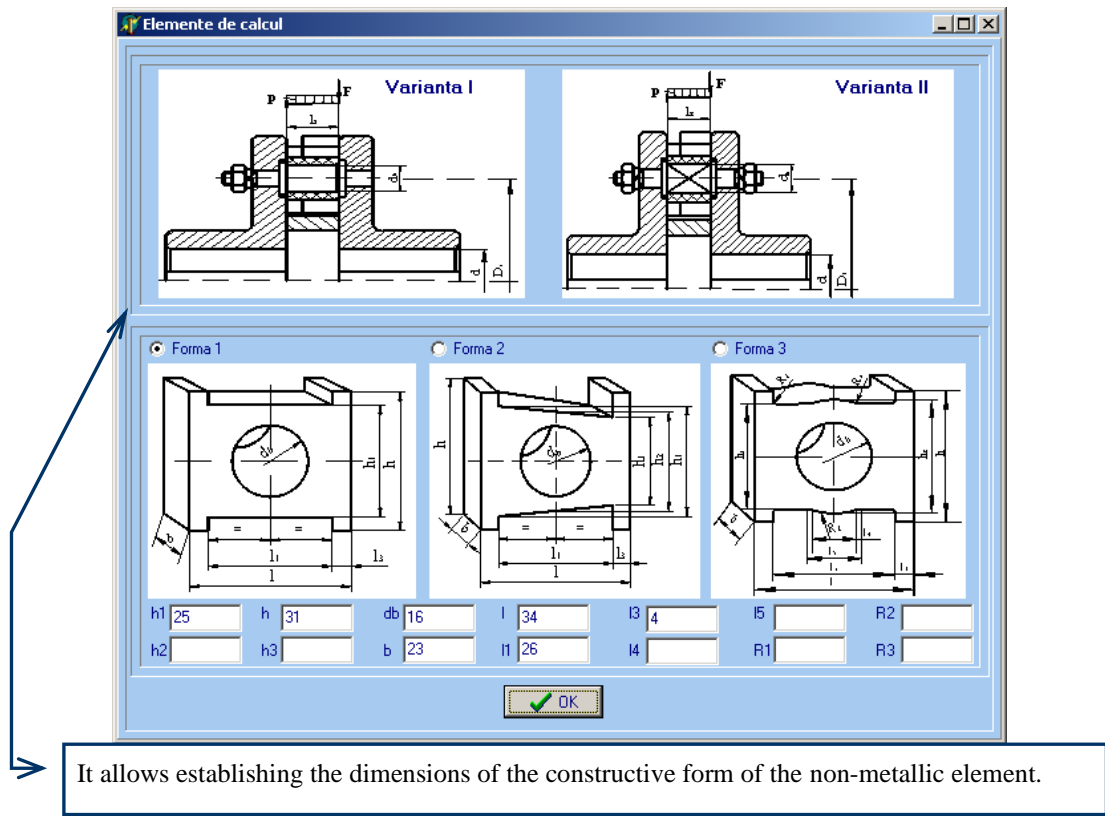


Figure 7: Selection of form of non-metallic elements

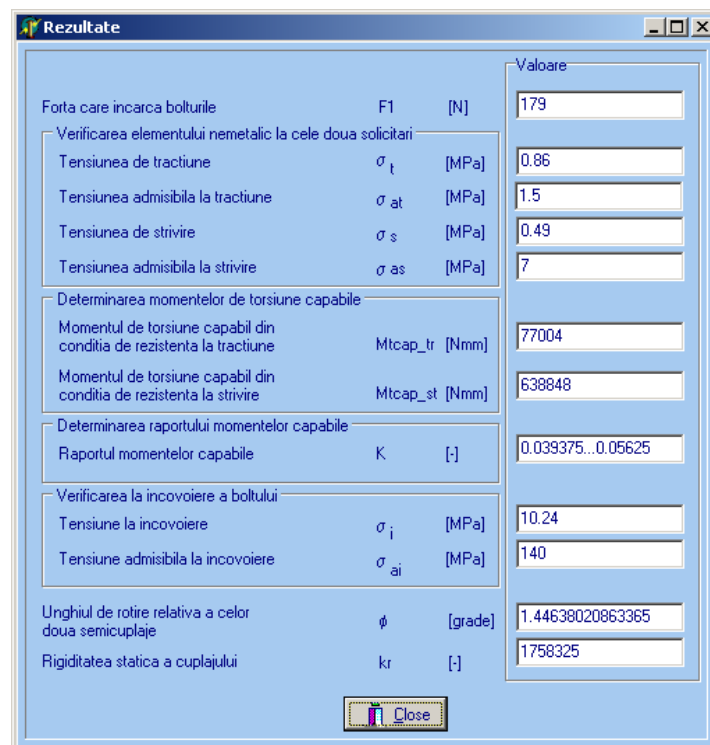
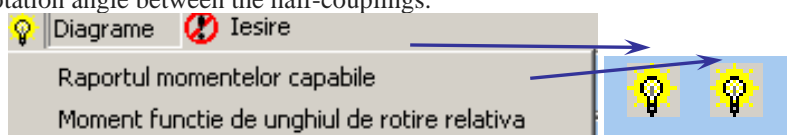
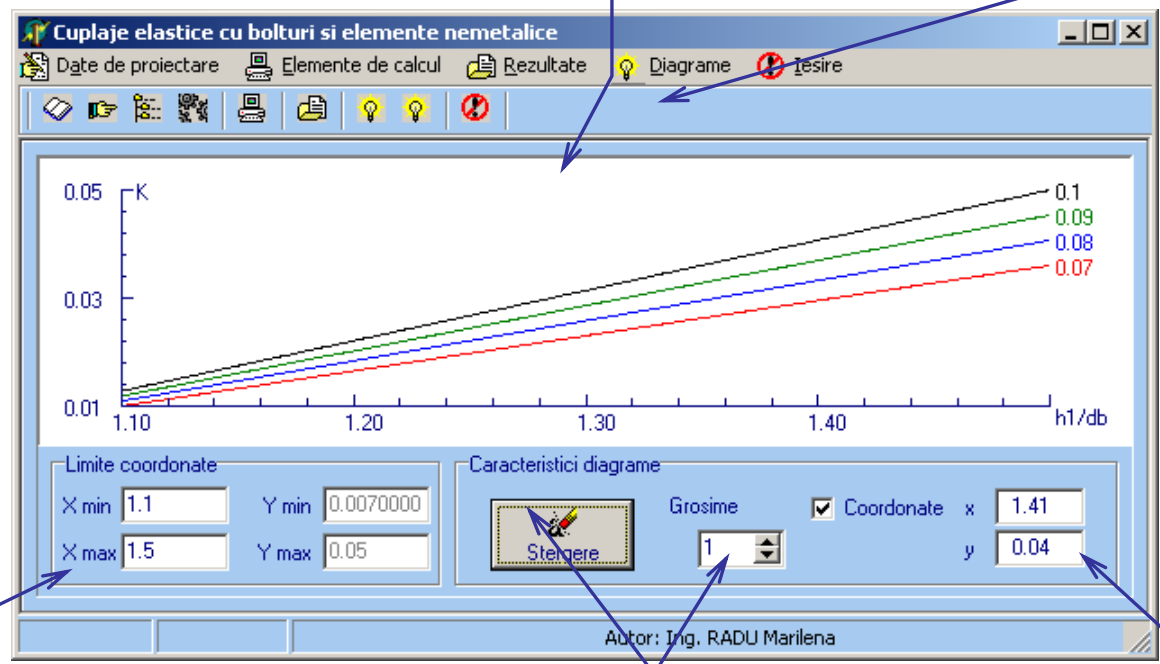


Figure 8: Results

It allows to draw the desired diagram from the drop-down lists for the ratio of the capable moments according to the ratio $\left(\frac{h_1}{d_b}\right)$, respectively the calculation torque according to the relative rotation angle between the half-couplings.



Graphic window.



Allows you to set minimum and maximum values corresponding to the coordinate limits for the abscissa and the ordinate.

Allows you to display the coordinates of a point of interest on charts.

Allows you to clear the graphics screen after changing chart boundaries or redrawing other charts.

Allows you to set the thickness of the line with which the respective diagram will be drawn.

Figure 9: Variation the ratio of torsion moments capable according to the ratio $\left(\frac{h_1}{d_b}\right)$

In figure 8 the following are noted:

- the non-metallic element resists traction and crushing, the crushing request being the main demand.
- From the condition of traction resistance and crushing of the non-metallic element, it is found that the capable torsion moment obtained from the crushing resistance condition is greater than the value of the torsion moment capable of the traction resistance condition.

- Bolts resist bending.

The "Charts" window (fig. 9, fig. 10), following calculations made hidden to the operator, allows the following graphs to be drawn separately:

- Drawing the graph of the ratio of the torsion moments capable (K_{F1}, K_{F2}, K_{F3}) corresponding to the selected constructive shape of the non-metallic element according to the ratio $\left(\frac{h_1}{d_b}\right)$, respectively $\left(\frac{h_2}{d_b}\right)$,

between them there are relations:

$$K_{F1} = (0,1...0,007) \left(\frac{h_1}{d_b} - 1 \right) \quad (1)$$

$$K_{F2} = (0,1...0,007) \left(\frac{h_2}{d_b} - 1 \right) \quad (2)$$

$$K_{F3} = (0,1...0,007) \left(\frac{h_2}{d_b} - 1 \right). \quad (3)$$

Figure 9 shows that the variation in the ratio of torsion moments capable according to the ratio $\left(\frac{h_1}{d_b}\right)$ is linear.

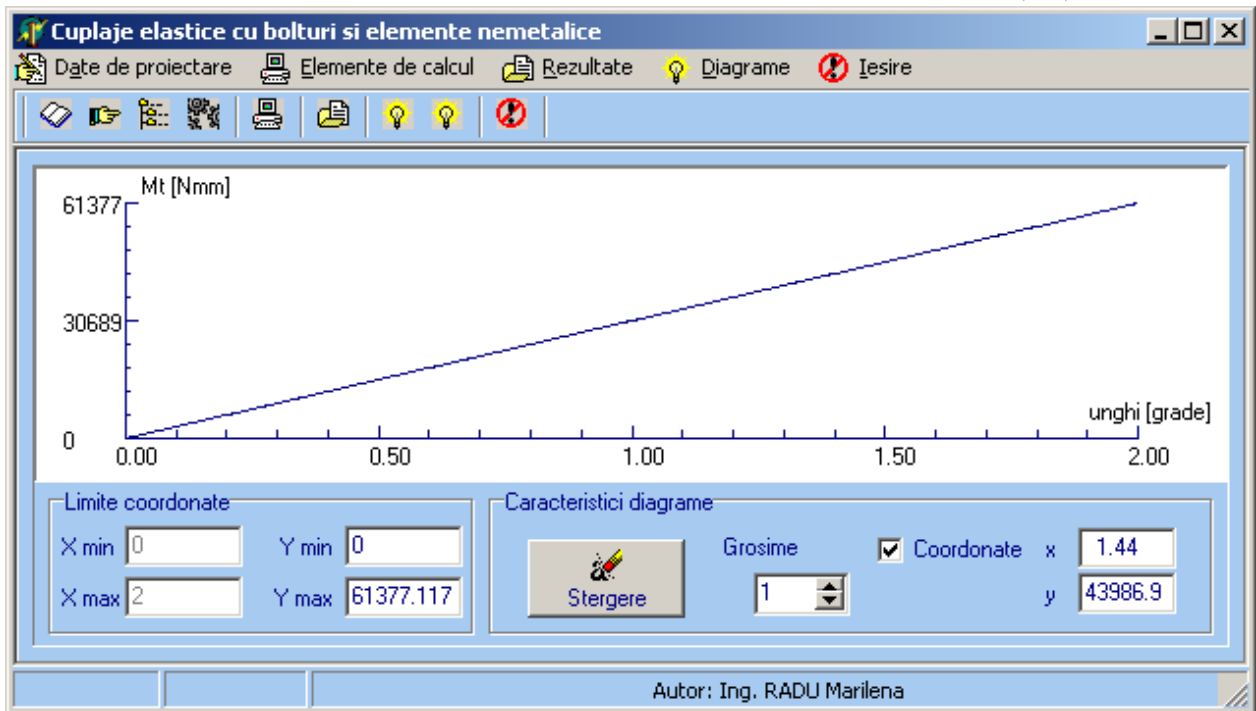


Figure 10: Diagrams

- Plotting the moment of calculation torque depending on the relative rotation angle of the two half-couplings $M_{tc} = M_{tc}(\Delta\varphi)$, (fig. 10), corresponding to the selected non-metallic shape, with the possibility of establishing the line thickness and viewing the coordinates by locating a point on the graph.

3. CONCLUSION

In the present paper was presented an original computerized design program of the new constructive variants of elastic couplings with bolts and non-metallic intermediate elements, which allows both constructive design and plotting the torque variation diagrams in static operating conditions, $M_{tc} = M_{tc}(\Delta\varphi)$, for different values of the geometric parameters and $K_{F1(2,3)}$.

The presented calculation program fulfills the objectives established initially, being a calculation program with a very great generality and which allows further developments. The calculation algorithm underlying this program is original.

The study method proposed through the program is interactive through the facility offered to the operator, during the functional modeling process, to choose between several working hypotheses.

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