VIRTUAL INSTRUMENT FOR SIMULATING THE DEFORMATION OF A FIXED BAR AT ONE END UNDER THE ACTION OF THE FORCES

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ABSTRACT: This paper describes the results obtained through the design and development of a virtual instrument made in LabVIEW. The virtual instrument calculates the strength of the material for a specific application. The virtual instrument allows the calculation of the reactions for a cylindrical bar made up of two sections and fixed at one end, the checking of the bar in all bar segments, the elongations of the bar sections, and draws the axial stress diagram. The bar is subjected to the actions of the three forces at three different points.

KEYWORDS: LabVIEW, reaction, elongation, axial stress.

1. Introduction

Solving problems in the field of material resistance requires laborious and complex mathematical calculations. Sometimes, mistakes can be made in performing calculations that can lead to erroneous results. In addition, the time required for calculating the results and plotting the diagrams is quite high.

The virtual instrument allows the quick and correct calculation of the reactions for a cylindrical bar made up of two sections and fixed at one end, based on the formulas given by the specialized literature. The calculation formulas depend on the type of bar, the type of force application and the type of support of the bar.

Regardless of the values specified as input data, when the program runs, the bar loading diagram and the axial stress diagram will be drawn, depending on the values entered as input data in the problem.

2. Status

The cylindrical bar is made up of two sections and fixed at one end. The loading scheme is represented in Figure 1.

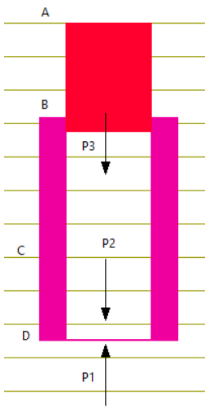

Fig. 1. Cylindrical bar with two sections

The steel bar (R = 235 N/mm^2 and E = 2.1x 10^5 N/mm2) is fixed at the end point A. It consists of two sections: AB of the circular section with diameter D_{AB} and section BD of the annular section with outer diameter $D_{BD.}$

To check the resistance condition, neglecting their weight, the calculation relationship used is given by formula 1 [1]**:**

$$\sigma = \frac{N}{A_{Ef}} \leq R \qquad (1)$$

where:

R – calculated tensile/compressive strength of the material.

A_{Ef} – the effective cross-sectional area of the axially loaded bar.

N – axial effort.

The axial load to which the bar is subjected will be strech when N > 0 and compression when the value of N < 0.

Formulas 2, 3 and 4 were used to draw the axial stress diagram starting from the free end (D) towards the embedment [1].

$$N_{CD} = -P_1 \qquad (2)$$

$$N_{BC} = -P_1 + P_2 \qquad (3)$$

$$N_{AB} = -P_1 + P_2 + P_3 \qquad (4)$$

The elongations of the bar sections were calculated using formulas 5, 6 and 7.

$$Def\ AB = \frac{N_{AB} * L_{AB}}{A_{AB} * E} \qquad (5)$$

$$Def\ BC = \frac{N_{BC} * L_{BC}}{A_{BC} * E} \qquad (6)$$

$$Def\ CD = \frac{N_{CD} * L_{CD}}{A_{CD} * E} \qquad (7)$$

3. Description of the virtual instrument running

The following controls are available on the front panel, used for specifying input data: numeric type controls named R, E, P1, P2, P3, D AB, D BD, L AB, L BC and LCD [2].

When running the program, the virtual instrument will display the calculated results in numerical indicator elements named as follows: N AB, N BC, N CD, S AB, S BC, S CD, Def AB, Def BC, Def CD.

Also, the virtual tool will display in the XY Graph indicator element, the axial stress diagram, and the bar section according to the values received from the numerical control elements.

Figure 2 shows the image of the front panel of the virtual instrument with the control elements and the indicator elements mentioned above.

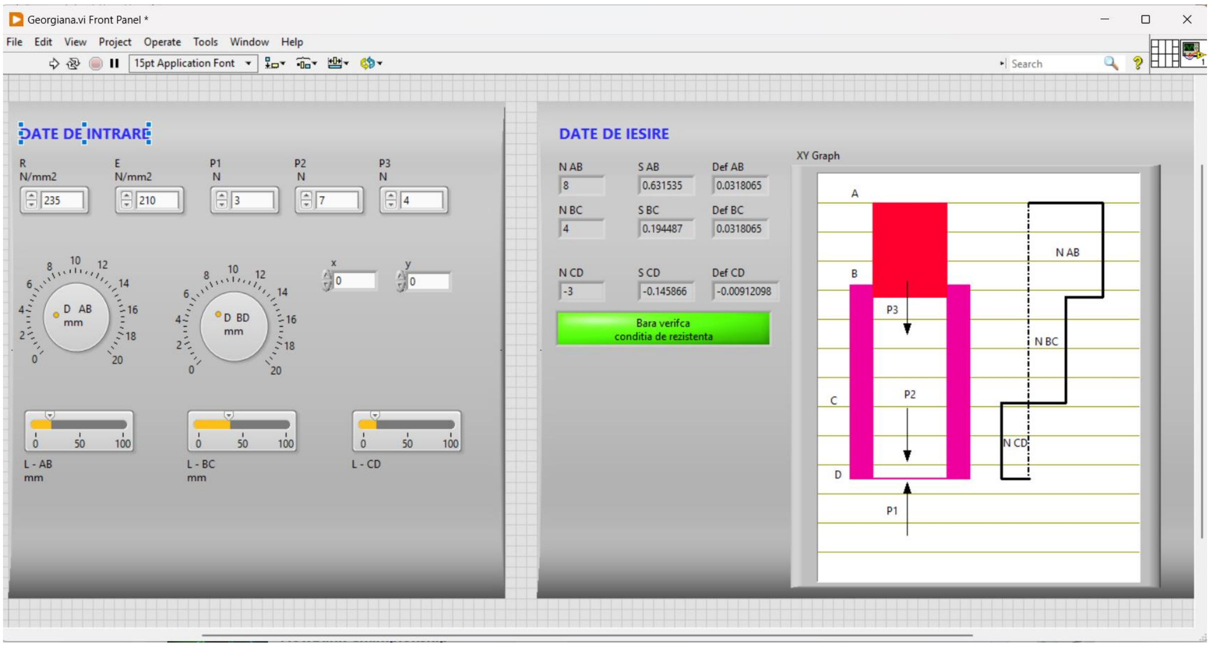

Fig. 2 Application front panel

4. Description of the virtual instrument algorithm

In the virtual instrument diagram, the Formula Node structure was used to calculate the results of the problem. In the Formula Node structure, formulas 1 - 7 were introduced, respecting the order of operations in arithmetic. Each expression was ended with a semicolon.

The tensions calculated for the three sections were compared with the admissible tension with the Less function. If all conditions are met simultaneously, the program will display the corresponding message in the LED indicator element [3].

Figure 3 shows the diagram with the programming algorithm for calculating the results.

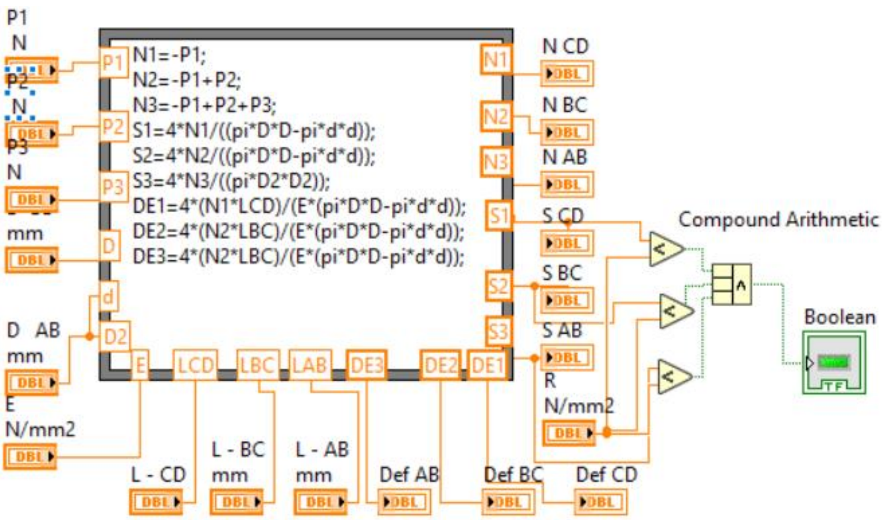

Fig. 3. Algorithm for calculating the results

The representation of the drawing was obtained by the simultaneous representation of several graphics using the Build Array function.

Each graph was obtained by a cluster constructed with the Bundle function. Each cluster contains the string of values of the numerical coordinates X and the string of values for Y.

Each array was built with the Build Array function.

To simplify the diagram, local variables were created for the control elements, respectively the indicator elements through which their numerical values were read, and which were used to calculate the coordinates of the points through which each graph was drawn.

Figure 4 shows the algorithm for the graphic representation of images.

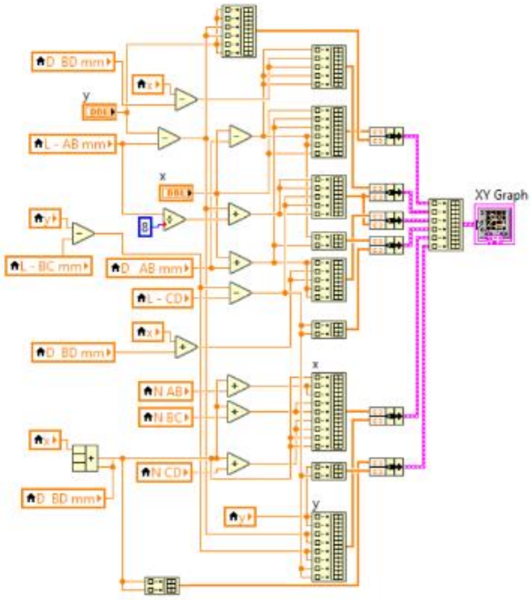

Fig. 4. Algorithm for the graphic representation of images

5. Conclusion

The created virtual instrument correctly and efficiently solves a concrete material strength problem based on the formulas from the specialized literature. It has a simple, intuitive, and easy-to-use interface for users with any programming experience.

It is recommended to improve the interface with the programmer by obtaining drawings with the help of Pictures-type functions as future research directions.

Also, the writing of calculated results and drawings in a report or files is taken into account to be accessible to any user without the need for LabVIEW software.

6. Bibliography

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