VIRTUAL TOOL FOR CALCULATING RIVET JOINTS

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ABSTRACT: Riveting is the technological process of non-removable joining of two or more parts, using machine components called rivets. This virtual LABVIEW (VI) tool allows the riveting assembled parts to be checked, as required by external axial forces for the following three types of requests: Axial load (tension or compression), shear request, crushing request.

KEYWORDS: LABVIEW, rivets, force, demand.

1. Introduction

Riveting assembly is an operation by which two or more tables merge and become unremovable. This procedure provides safety in the operation of welded assemblies and constructions subject to dynamic loads such as bridges, aircraft, marine and river ships, etc.

Depending on the type of production, the operation can be performed mechanically or manually. Depending on the diameter of the rod, it can be performed at low or high temperatures – if it is less than 6 mm, the assembly is done cold, and at a larger diameter, hot.

The rib it is a cylindrical body fitted at one end with a cylindrical, tronconic or bulging head, and the other head is obtained by plastic deformation. Its component parts are visible in Figure 1: The starting head (a), the rod (b) and the closing head (c). Rivets are made of various materials depending on the materials of the parts to be assembled, as well as the forces to which the assembly will be requested.

The main features that materials for rivet making must meet are sufficiently high tensile strength and good plasticity.

At the joining of two plates by riveting, at each rivet, two equal forces of opposite direction are transmitted, as shown in Figure 1.

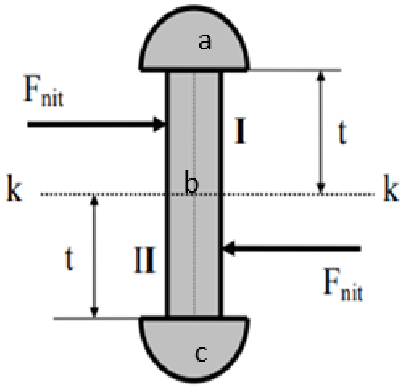

Fig 1. Ribit and applied forces

2. The current stage

If for joining are used **in rivets**, on each rivet, two equal forces of opposite direction, called forces on the nit**:**

$$F_{nit} = \frac{F}{n} \tag{1}$$

Forces on the rivet tend to scissors the rivet after the k-k separation plane of the two plates.
If the rib is required to **shear,** and has only one shear surface at the level of the separation plane between the two platbands, the calculation relationship is:

$$\tau_{max} = \frac{F_{nit}}{A_f} = \frac{F_{nit}}{\frac{\pi d^4}{4}} \tag{2}$$

Where:
maximum tangential voltage;
Af - aria suprafeţei forfecate (aria de forfecare);
d - diameter of the rivet;

If the ribit is required to **crush,** the calculation relationship is:

$$\sigma_{maxs} = \frac{F_{nit}}{A_s} = \frac{F_{nit}}{t * d} \tag{3}$$

Where:
σmax - maximum normal crushing voltage;
As - area of crushed surface (crushing area);
t - the thickness of the platter;

For **axial demand**, the calculation relationship is:

$$\sigma_{max} = \frac{F}{A} = \frac{F}{(b-d) * t} \tag{4}$$

Where:
σmax - axial tension;
b - latimea platbandei;
t - the thickness of the platter;

3. Description of the functioning of the virtual instrument

Depending on the size of the rivet and plates, the program will represent the drawing of the rivet in a 2D picture indicator element.

Also, depending on the type of request, the program will calculate the voltages and compare them with the allowable values. Each variable specific to the type of request will remain visible or not with the properties in the element control panel.

The values of forces and tensions were calculated using Formula Node structures in which the necessary formulas were passed, and the drawing of the rivet was made using **the functions draw Rectangle.vi, draw Circle by radius.vi, move Pen.vi** and **draw line.vi.**

The following control elements are available on the front panel, required to specify the input data:

The force at which riveting assembly is required (**vertical pointer slide numeric** element called "force"), the number of rivets (numerical control element called "No. Rivets'), diameter of rivets (Knob numeric element called 'rivet diameter'), thickness (**horizontal Pointer Slide numeric element referred to** as 'flatbed thickness'), width of plates (**controllable numeric element called** 'width') and the 3 permissible voltages for each request (**controllable numerical elements called** 'SS admissible' for crushing, 'S admissible' for axial and 'T admissible' for shearing

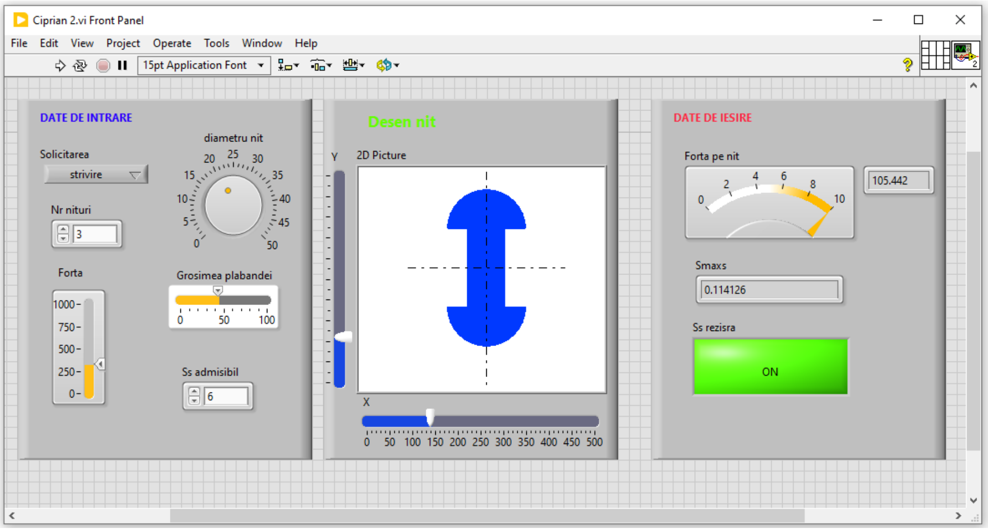

Fig 2. Application front panel

The application will also display the force applied to the rivet, calculate the maximum voltage and check if the assembly of the parts resists the maximum voltage by lighting a green bulb.

4. Description of the virtual instrument algorithm

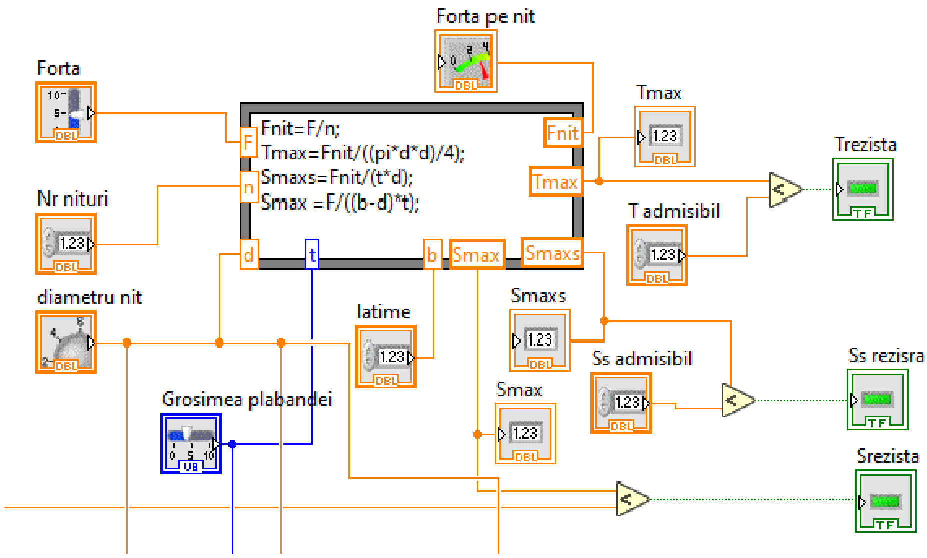

Fig. 3. Calculation of force and tension

In the diagram of the virtual instrument, the formula node structure was used for calculating the force and the voltages respectively. Formulas 1-4 were introduced in the structure, separated by enter, at the end a point and a comma were added.

The results of the voltages were compared with the allowable voltages of each request to check whether the rivet could withstand force or not. If so, each led will light up with a green color; otherwise, the led color will be red.

Figure 3 shows the diagram of formula calculations and the verification of the rivet.

The drawing was made through a 2D picture structure in which different basic functions were used that create geometric shapes and change coordinates. Each geometric shape was created and moved to make the scheme of the rivet, with different characteristics such as color, size and coordinates of each. Thus, the ribit was created from a rectangle, 2 semicircles and the 2 axes of symmetry were created.

The lengths and points where it is located have been calculated in a Formula Node structure, the results being linked to each function to draw the ribit. The coordinates of each point were created by tying an x and y into a bundle. Figure 4 shows the diagram that draws the ribit in 2D picture structure.

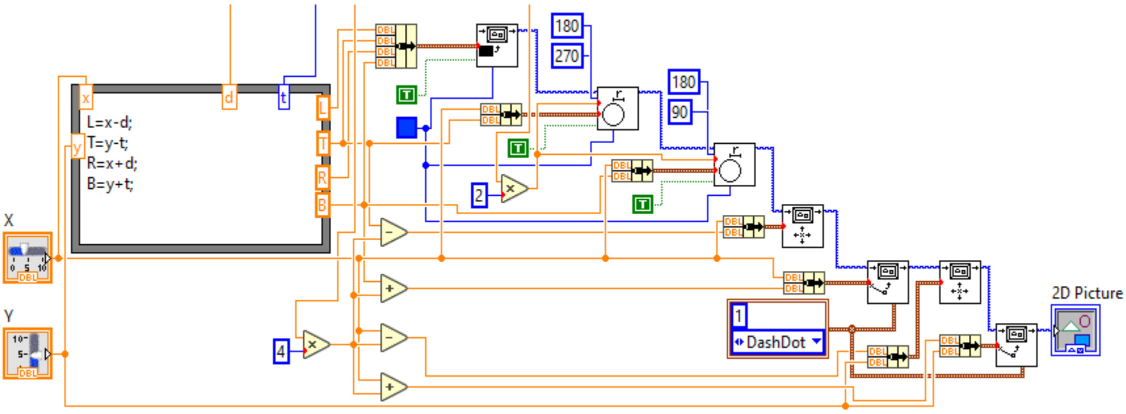

Fig. 4. Drawing the rivet in the 2D picture structure

The application at the time of selecting a request (out of the 3 existing ones) will make its items remain visible and those that do not need to disappear. This is possible by using nodes in the control panel of each item.

Each request will have visible the necessary elements linking the visible nodes to the respective request. Figure 5 shows the appearance and disappearance of the elements.

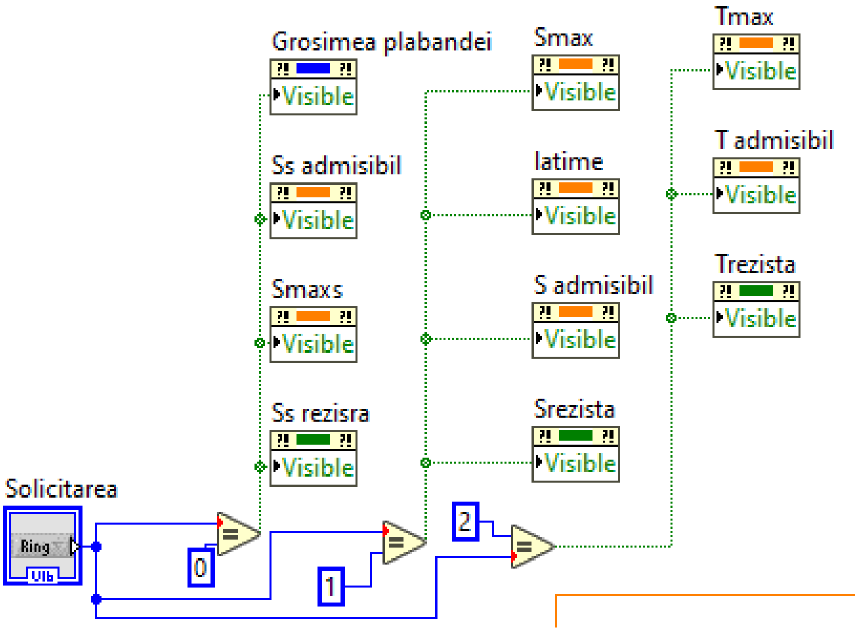

Fig. 5. Visibility of panel elements

5. Conclusions

This virtual tool correctly and efficiently solves a problem of the resistance of materials, based on formulas from the literature. The interface of the application is simple, and the algorithm is easy to use by both a specialist user and a beginner.

Making a virtual tool for calculating riveted joints through the clasps. In the case of joints riveted by means of the shins, the force is transmitted through the first group of rivets from one platter to the two shins, and then from the latter through the second group of rivets to the second platter.

It is suggested to write calculations and drawings in a file or report for safer accessibility that does not require the installation of LabVIEW software.

6. References

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