RESEARCH ON ESTABLISHING THE DIMENSIONS OF THE SEMI-FINISHED PRODUCT AND THE OPTIMISATION OF STAMPING PATTERNS

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ABSTRACT: The paper aims to design an algorithm and a computer application that will determine the dimensions of the flat surface of the semi-finished product in order to obtain an optimal cut. The dimensions of the flat surface of the semi-finished product will be determined, through the application, by means of specific calculation operations according to the dimensions of the product taken from its 2D execution drawing. The computer application will optimize the stamping scheme according to the need expressed on the number of workpieces of the user and according to the standard calculations required when cutting strips or sheets.

KEY WORDS: semi-finished product, cutting, stamping, algorithm, LabView

1. Introduction

Stamping is a cold deformation process, without cutting, of objects of the same shape, from tables, strips, discs, or wires. This operation is performed by cutting with the help of stamps.

Cold deformation is one of the oldest methods of transforming metal into useful objects. Currently, most metal parts processed by deformation are utilised within the body elements of several types of vehicles, in a percentage of 60-70% [3].

Treating/ Cutting/ Tailoring the boards and strips represents the distribution on the surface of the product with well -defined forms, in order to cut them in such a way that the amount of unused material is minimal, contributing considerably to reducing the production cost of the representations manufactured en masse [4].

2. The current stage

Currently, there is a very small number of such applications in the industry, most of which have a complexity that does not fully meet the requirements associated with the research topic. The first example of a complex application, which has several advantages, is Metalix; an application that deals with the simulation of processing procedures. This application is easy to use, but does not focus on obtaining a single piece with a stamp/ mould with simultaneous suction, but several marks are processed which are suitable for a combined cut using as a main semi-finished product, a metal sheet. Two other examples of applications that are suitable in this domain are Deepnest and Mynesting, two applications that largely deal with the arrangement of parts on the sheet for numerical control machines. In conclusion, there is no application at this time in the industry that focuses on the finished piece and its processing on stamps and moulds with successive actions [5].

At this time, because there are no applications that will treat the optimization of the crossing using a tape semi -finished product, the classic method for calculation and optimization is still used. The succession of the calculation stages, defined in the specialised literature, include:

- Calculations for unfolded bent parts [1, 2]:
    - r = 0

$$l = \sum_{i=1}^{i=k} l_i + k * g * (n - 1) \quad (1)$$

l- the length of the unfolded part; G - the thickness of the material; Li - the length of the rectilinear portions; N - the number of rectilinear portions; K - coefficient that takes into account the radius.

- $r \neq 0$

$$L = \sum_{i=1}^{i=k} l_i + \sum_{i=1}^{i=k-1} l_{\varphi i} \quad (2)$$

L - the length of the unfolded part; Li - the length of the rectilinear portions; K - the number of rectilinear portions; lφi - the length of the neutral layer of the bent portion

$$l_{\varphi i} = \frac{n * \varphi_i}{180} * (r_i + x * g) \quad (3)$$

φi - the angle of bending; ri - the inferior bending ray; X-coefficient that takes into account the movement of the non-layer and whose values are given in a specific table.

- Tailoring analysis. In order to have an optimal tailoring, you need to make calculations for the most correct placement of the part on the metal sheet. The decks necessary for the cut are A, B, C and the step p. following the establishment of these values, the efficiency of the tailoring is calculated [1, 2].
  - Decks A and B are calculated as per the following formulas:

$$A=k_1*k_2*k_3*a1 \quad (4)$$

$$B=k_1*k_2*k_3*b_1 \quad (5)$$

- k_1, k_2, k_3, a_1, b_1 are values that differ depending on the material category and the thickness of the metal sheet and can be found in the specific tables in the specialized literature..
  - Deck c differs depending on the thickness of the metal sheet and is found in a specific table in the specialized literature.
  - Step P, is calculated by gathering the length of the piece with deck A..
  - Tailoring efficiency is calculated using the formula:

$$k_c = \frac{n * A}{p * l_s} * 100 \, [\%] \quad (6)$$

n - the number of tailoring rows; A - the area of the piece determined by the outer contour; P - the tailoring step; Ls - calculated width of the tape.

3. Developing the methodology of the desing algorithm

The algorithm aims to establish the dimensions of the semi-finished product by the calculation of the finished part considering a minimum interaction with the user. Following the calculation, the dimensions will be displayed on both the X axis and on the Y axis of the flat surface. This data is subsequently used to optimize the stamping tailoring according to the desired material category and the desired number of results. User input is necessary in choosing the values necessary for the calculations so that they are as close as possible to a correct and accurate optimisation. Finally, the user will be able to view the necessary dimensions for the metal sheet or band to be processed, the quantity of the remaining material and a drawing that represents in a minimalist way the distribution of the finished products on the surface of the semi-finished product. Figure 1 represents the overall running process of the application

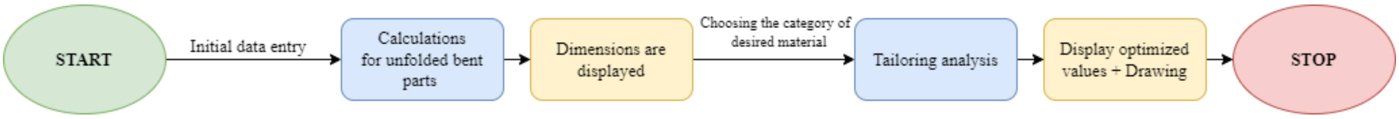

Fig. 1 – The overall running process

4. Developing the application

The proframic environment used to create the application is LabView, an accessible and efficient working tool in relation to the purpose imposed by the research theme. The whole program is integrated into a While Loop, and in the following you can see the components in the described order and in the main diagram.

Figure 2 shows the interface for the calculation of the piece. This contains both the data that the user will have to enter and some helpful information in in relation to it.

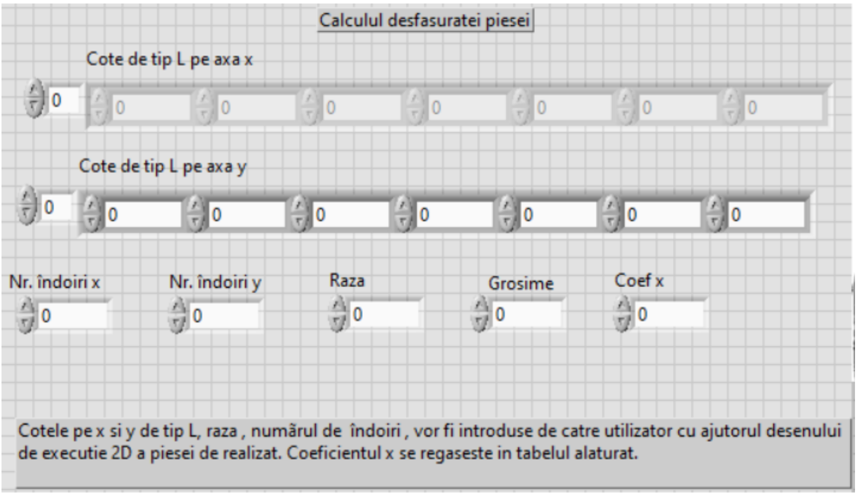

Fig. 2. Calculation of the unfolded piece (Front Panel)

Figure 3 presents the structure of the program with the operations necessary for the calculation necessary for the part. Each function used has a label to help the user easily follow the structure of the elaborate algorithm.

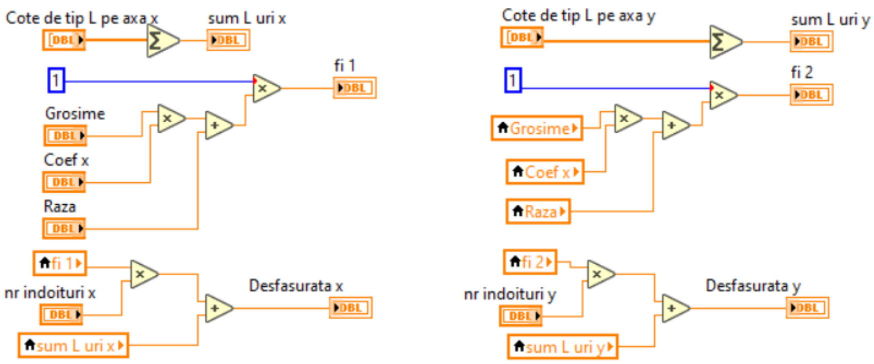

Fig. 3. Calculation of the unfolded piece (Block Panel)

Figure 4 presents the interface of the program for analysing the semi -finished product. In this section of the program, the user will be able to enter the necessary data and will be able to choose the desired material category for an optimal tailoring.

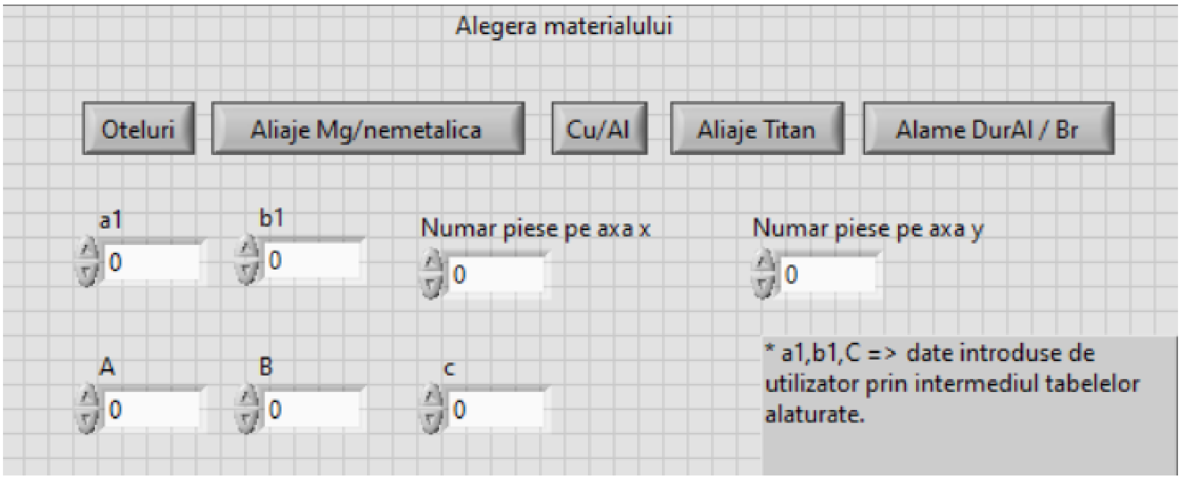

Fig.4 - Tailoring (Front Panel)

Figure 5 presents the structure of the algorithm used for the calculation of the cut and the algorithm necessary for the drawing that contains the exemplification of the method of cutting and the arrangement of the semi -finished product.

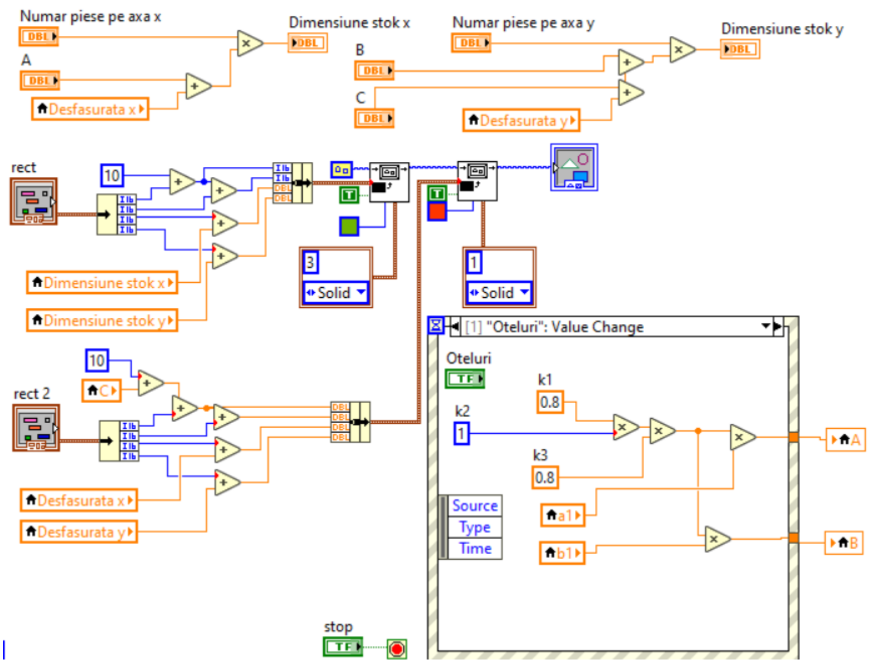

Fig.5 - Tailoring (Block Panel)

Figure 6 represents the model drawing to exemplify the method of cutting and the arrangement of the semi -finished product.

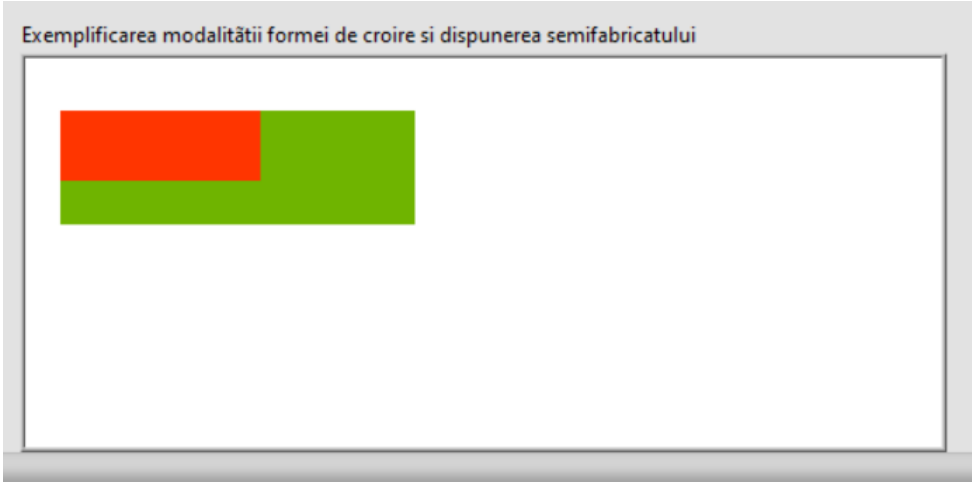

Fig.6 - Exemplification of the way of cutting and the arrangement of the semi-finished product

Figure 7 shows other elements from the program interface. These items are necessary for an easier use of the program and in order to help the user in understanding the way in which it works.

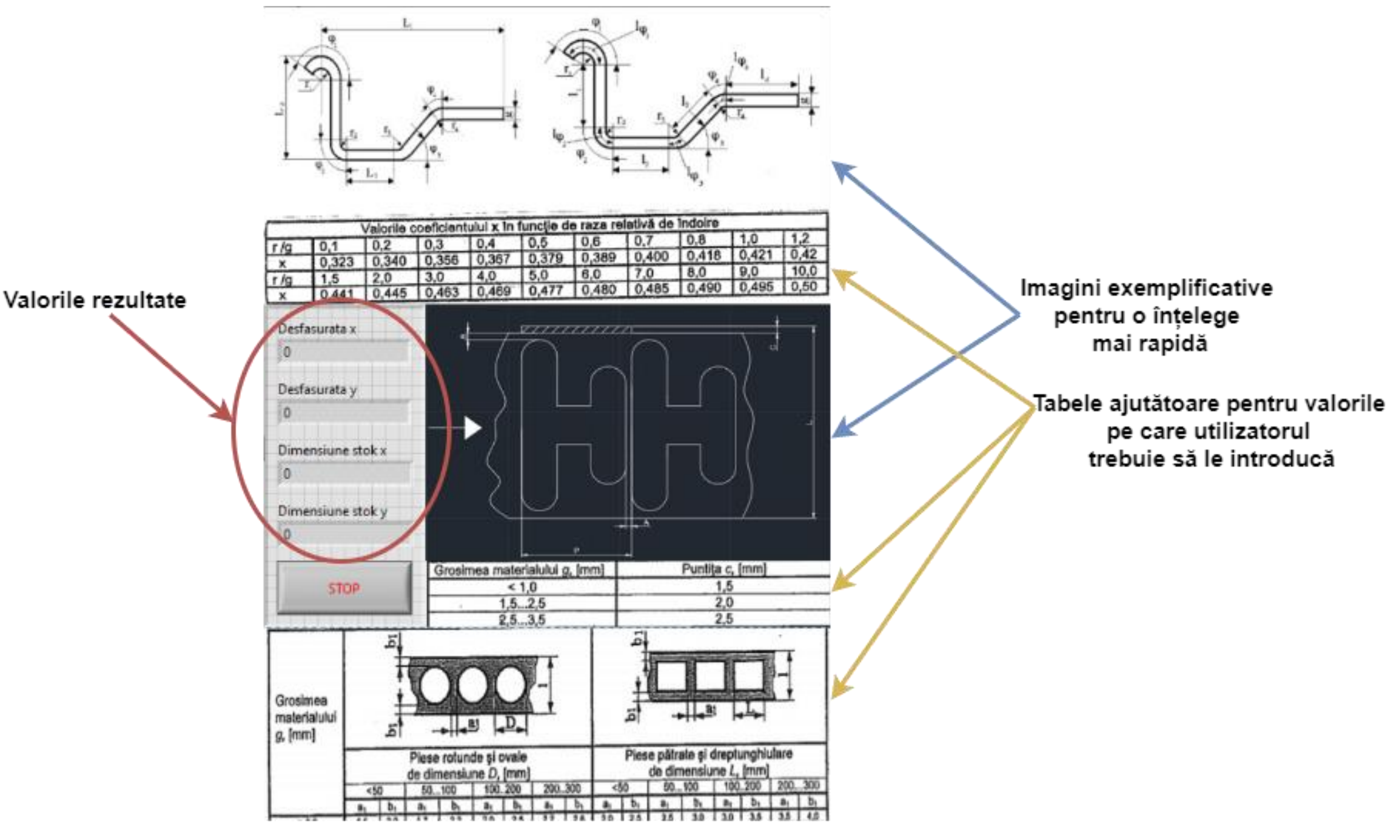

Fig.7 - Elements in the program interface

5. Conclusions

The developed application aims to create an accessible, easy -to -use program, that helps the desiging engineer in the design stage of cold deformation equipment, which implies the analysis and efficiency of the semi -finished products. The application contributes to the elimination of possible calculation errors that can occur during the use of the classical method, considerably reducing the time allocated to perform the calculations.

Subsequent developments of the application will also include calculations regarding the efficiency of the flat and bent parts, thus becoming a useful working tool in developing an optimal technological process, which aims to minimize the production cost associated with a landmark obtained by cold deformation.

6. Bibliography

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