THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 4 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.4.09

SIMULATION OF THE FORGING PROCESS OF A BEARING RING USING MATLAB SOFTWARE

Marian-Iulian NEACȘU
"Dunarea de Jos" University of Galati, Romania
e-mail: mneacsu@ugal.ro

ABSTRACT

In the current work, entitled "Simulation of the forging process of a bearing ring using MATLAB", we created a graphical interface (GUI) using MATLAB software, based on the mathematical relationships specific to the forging process of metallic materials.

By simulating the technological process of obtaining the bearing rings, the material and energy consumption conditions are precisely calculated and highlighted, for the realization of the different profiles of the bearing ring generator.

KEYWORDS: forging, modeling, MATLAB, graphic interface, bearing rings

1. Introduction

The first wrought metals were gold, bronze, and iron, used to make tools, weapons, and jewellery. Later, steel was introduced, and all of these metals were worked using a rock as a hammer, along with the heat generated by fire. This method remained the predominant method for forging metals and steel until the early 19^{th} century [1-3].

The forging of iron and other metals has been vital to the development of human civilizations for millennia. The ability to shape and work metals through forging was a significant step in technological progress since the Bronze and Iron Ages. This process is still as important today [2].

Providing a wide range of essential products, such as metal pipes and fittings, as well as sheet metal and profiles needed in various other industrial sectors, forging is often considered the "heart" of the metalworking industry. These robust and durable parts, obtained by controlled plastic deformation of metal, are essential to contemporary industrial infrastructure [3-5].

Forging is the process by which metal is hammered, pressed, or rolled into a specific shape. This can be achieved either with a hammer, a press, or a die. Essentially, it is the art of heating and working hot metal to obtain a specific design or shape for a specific purpose or use [6-9].

Many of the properties of the material, such as structure, conductivity, and longevity, are improved by machining.

Forging creates parts that have superior mechanical properties with minimal material loss. The starting material, which has a relatively simple geometry, is plastically transformed in one or more ways to create a fairly complex product. Forging usually requires quite expensive tools [10-12].

Simulation of a technological process in general consists of rendering its development based on mathematical models that describe the respective process, with the aim of highlighting the evolution of factors that characterize the final products and the technological process [13, 14].

Recently, virtual simulation has experienced extensive development, this is also due to the advantages that this type of simulation involves, namely: low material costs, does not require the use of tools, devices, installations, does not require energy consumption, does not require measuring equipment, does not pollute the environment etc. [14, 15].

2. Experimental conditions

In this work, a simulation of the process of obtaining rings of various sizes for bearings by forging was carried out using the MATLAB software.

When creating the MATLAB program that makes this simulation possible, all the mathematical expressions specific to the forging process were used.

The creation of the graphical interface for simulating the process of obtaining rings for bearings had as restrictive conditions the fact that the case was taken into account when: The height of the ring (Hinel) is less than or equal to the height of the semi-finished product (Hs).

The simulation of the process of obtaining bearing rings by forging includes the following stages:

Stage I - Initiation of the program made in MATLAB for displaying the Graphical Interface.

Stage II - Choosing the dimensions for the bearing ring.

Stage III - Simulating the mould extrusion.

Stage IV - Simulating the drilling of the semi-finished product.

Stage V - Rolling the rings.

3. Simulation results

Figures 1-6 show images with the graphical interface for simulating the bearing ring extrusion. Figure 1 shows the graphical interface at the beginning of the simulation. Figure 2 shows the graphical interface at the time of choosing the dimensions of the rings to be made. Figure 3 illustrates the extrusion stage of the mould (semi-finished product) from which, in the final stage, the bearing ring will be obtained by rolling. After completing the blank pressing stage, the simulation program also calculates the dimensions of the blank drilling mandrel, which are obviously based on the dimensions of the blank pressed.

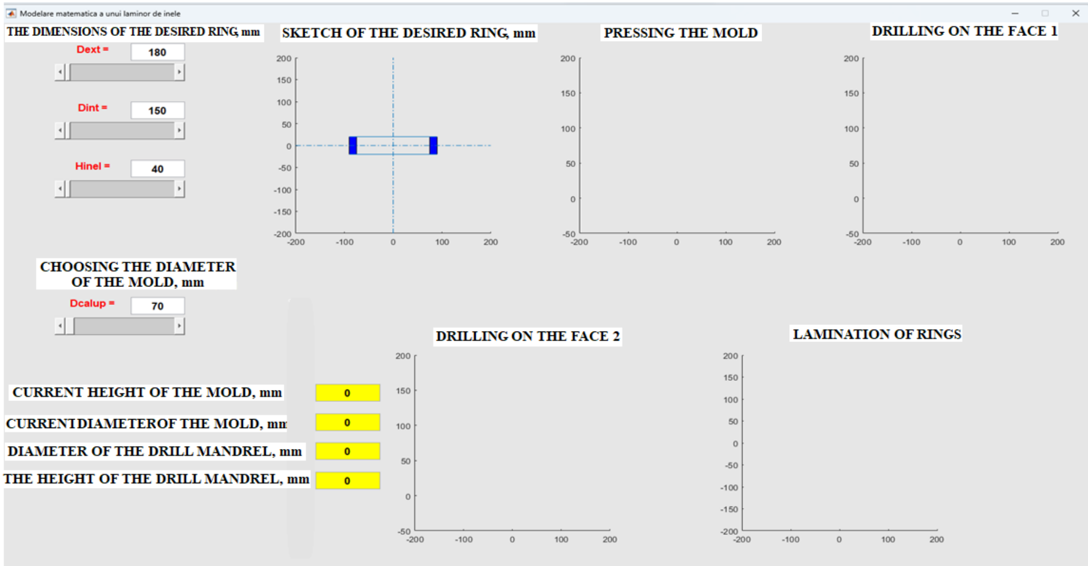

Fig. 1. *Stage I - Initiation of the program created in MATLAB for displaying the Graphical Interface*

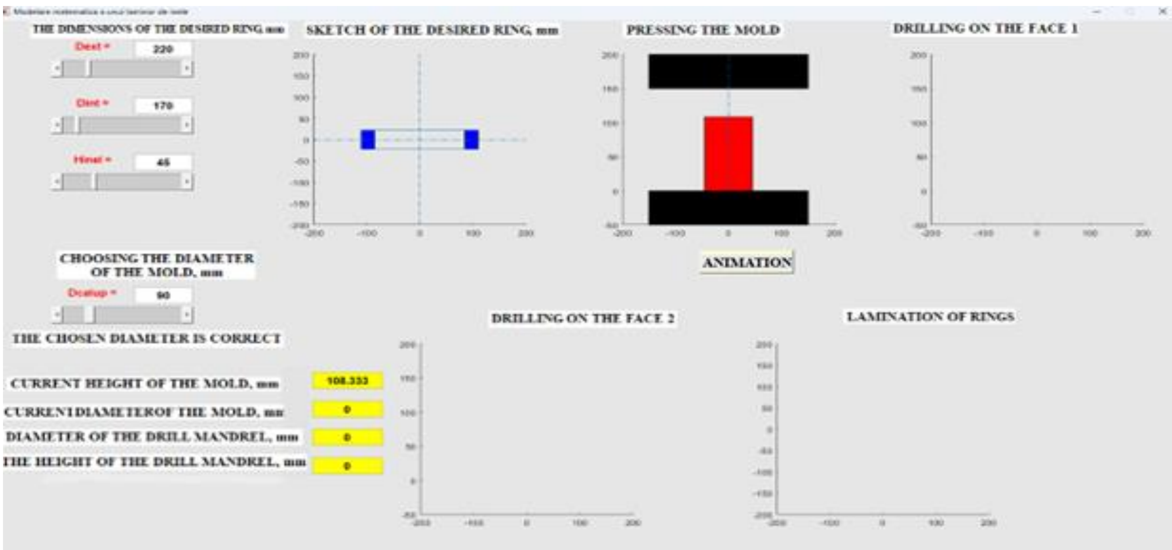

Fig. 2. *Stage II – Choosing the dimensions for the bearing ring*

THE ANNALS OF “DUNAREA DE JOS” UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 4 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.4.09

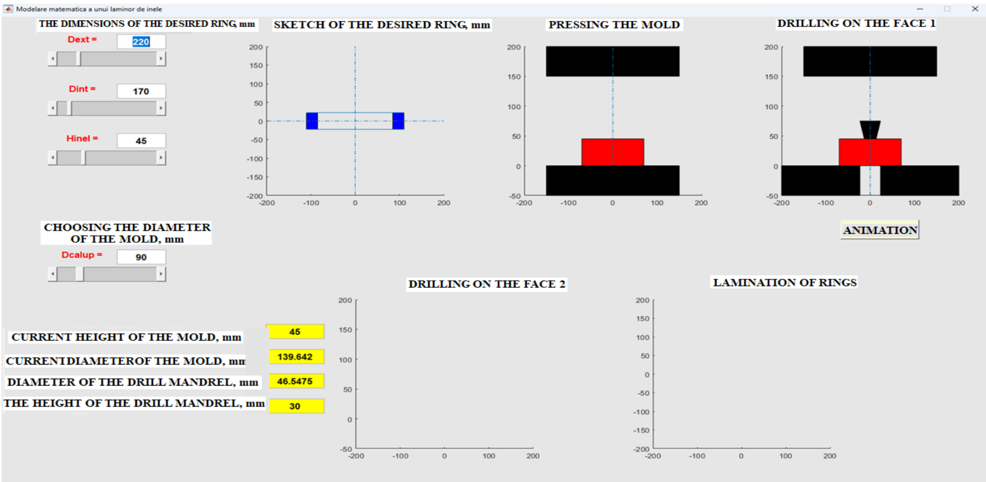

Fig. 3. *Stage III – Simulation of mold release*

Figure 4 and Figure 5 show the simulation of the drilling stage of the semi-finished product using the mandrel, in figure 4 drilling on face 1 and in figure 5 drilling on face 2.

In figure 6 the graphical interface shows the last stage in the simulation of the rolling process of bearing rings.

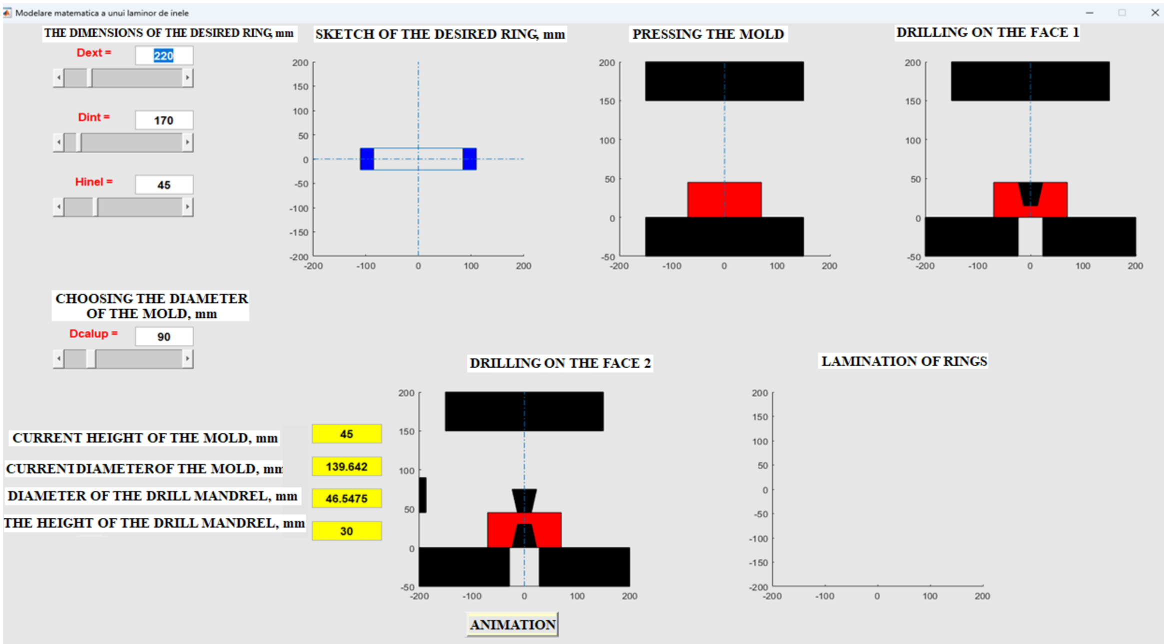

Fig. 4. *Stage IV – Simulating drilling of the blank (side 1)*

N°. 4 - 2024, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2024.4.09

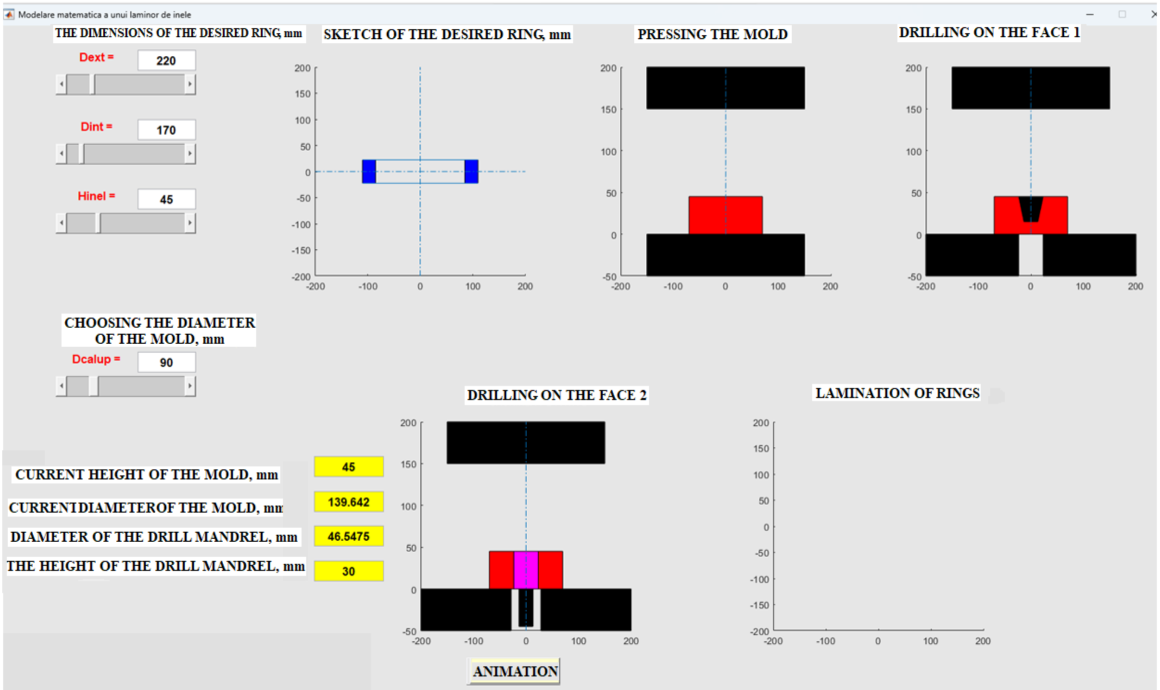

Fig. 5. *Stage IV – Simulating drilling of the blank (side 2)*

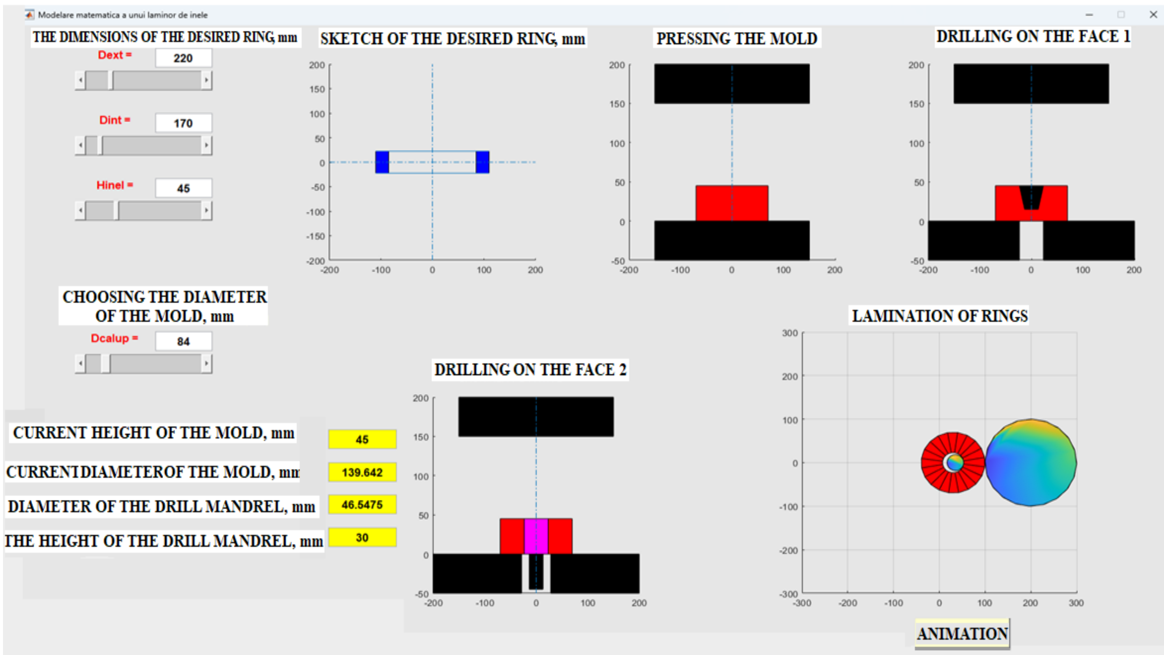

Fig. 6. *Stage V – Ring rolling*

4. Conclusions

Analytical and virtual simulation of a process, carried out using a computer and specialized programs, is based on the transposition of mathematical models into simulation software.

The advantages of both virtual and analytical simulations are:

- low material costs;
- does not require the use of tools, devices, installations;
- does not require energy consumption;
- does not require measuring equipment;
- does not pollute the environment, etc.

By simulating the rolling process of bearing rings, the user can control the process with greater precision, which leads to obtaining rings of better dimensional accuracy.

Also, by simulating the process, material losses can be prevented because through simulation, precise data regarding the dimensions of the initial semi-finished product from which the bearing ring is finally obtained is obtained. By avoiding material losses, energy savings can also be made.

The simulation of rolling of bearing rings allows highlighting the material requirements and energy consumption conditions for creating different profiles of the bearing ring generator.

References

[1]. ***, https://www.wasatchsteel.com/the-history-of-steel-and-metal-forging-part-1/.

[2]. ***, https://en.m.wikipedia.org/wiki/Forging.

[3]. ***, https://www.tfgusa.com/metal-forging-processes-methods/.

[6]. ***, https://www.iqsdirectory.com/articles/forging.html.

[7]. ***, https://typeset.io/search?q=forging.

[8]. ***, https://www.reliance-foundry.com/blog/forging.

[9]. ***, https://www.linkedin.com/pulse/forging-future-brief-overview-metal-industry maintenance world-com-xdfue.

[10]. ***, https://www.somersforge.com/what-is-forging/.

[11]. ***, https://www.scribd.com/doc/90995816/Forjarea-Metalelor.

[12]. ***, https://www.zx-hydraulic.com/news/free-forging-and-die-forging/.

[13]. Taloi D., *Optimizarea proceselor tehnologice – aplicaţii în metalurgie*, Editura Academiei, Bucureşti, 1987.

[14]. Popescu D., Ionescu F., Dobrescu R., Ştefanoiu D., *Modelare în ingineria proceselor industriale*, Editura AGIR, Bucuresti, 2011.

[15]. Ciucă I., Dumitriu S., *Modelarea şi Optimizarea Proceselor Metalurgice de Deformare Plastică şi Tratamente Termice*, Editura Didactică şi Pedagogică, Bucureşti, 1998.