ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

CONTRIBUTIONS TO THE DIVERSIFICATION OF MODULAR CAVITY MOULDS FOR FOOTWEAR SHOES

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Abstract: *Usually, the prefabricated footwear soles are formed in moulds with unique cavities. Each sole model requires one set of moulds and the set must contain at least one mould for each size number. Considering the great number of sole models, sentiments and size series, whatever the production size, the cost for moulds production and soles production is significant. In this paper are presented solutions that lead to possibilities of using the same set of moulds to obtain various models of soles. There are presented solutions for sole model diversification by modifying the cavities of existing moulds as well as solutions for designing moulds with modular cavities which are different from the classical ones. Through the development of this solutions was aimed the increasing of the exploitation efficiency of the available moulds and decreasing of the time needed and costs of production for new sole models. Experiments have shown that the moulds with modular cavities can be manufactured faster and with smaller costs then the moulds with unique cavities. This has as an immediate effect the faster launching into production and on the market of mew sole models and with smaller prices. Introducing in the sole fabrication process of moulds with modular cavities, as the only solution or in conjunction with the classic moods, opens new perspective in this domain.*

Key words: : *shoes soles, designing soles, manufacture soles*

1. INTRODUCTION

The prefabricated footwear soles, excepting the leather soles, are obtained in moulds through thermo-chemical processes using polymeric blends [1]. The market demands a great variety of sole models and that implies a great number of moulds. The classic moulds used for sole forming have unique cavities that don't allow the production of multiple spatial shapes of the cavities in the same mould. For each new sole model are needed individual sets of moulds. Considering that the soles role in footwear diversification is increasing, it is necessary to produce a great variety of mould sets. Each set of moulds hast to contain the entire size series. Consequently, the set has to contain at least one mould for each size number for one sole model [2].

Because of the complexity of the cavities, the time and cost of the production are high. This justifies the use of the mould on their entire production capacity. A smaller use of the mould is not efficient. A mould in which are formed soles, whatever the thermo chemical process is used, will be physically outworn after about 200000 working cycles. Usually the moulds are used a number of cycles, then are stored till new orders, and after a time the moulds are sent for recycling or melting, depending on the material used for their fabrication. The exploitation of the moulds till the outworn is seen in high sole production, at major manufacturers. In the case of the smaller manufacturers, the moulds are morally outworn long before they are physical outworn. Often, because of the lack of new orders, entire sets of moulds are recycled. Obviously, manufacturing such sets of moulds is not profitable.

In this paper are presented solutions to obtain more cavity shapes in the same mould. There are

presented two variants: obtaining modulation cavities in classical moulds, with unique cavities; realizing modulation cavities in moulds designed different from the classical ones.

2. EXPOSITION

2.1 Solutions for manufacturing modular cavities in moulds with unique cavities

The cavities in which the soles are formed have unique design and are contained in the base board. In the cover board are mounted the pieces which will close the cavities and will form the weight removal cavities.

We'll consider a mould which closes a cavity in which is formed a specific model of footwear sole, as in Figure 1.

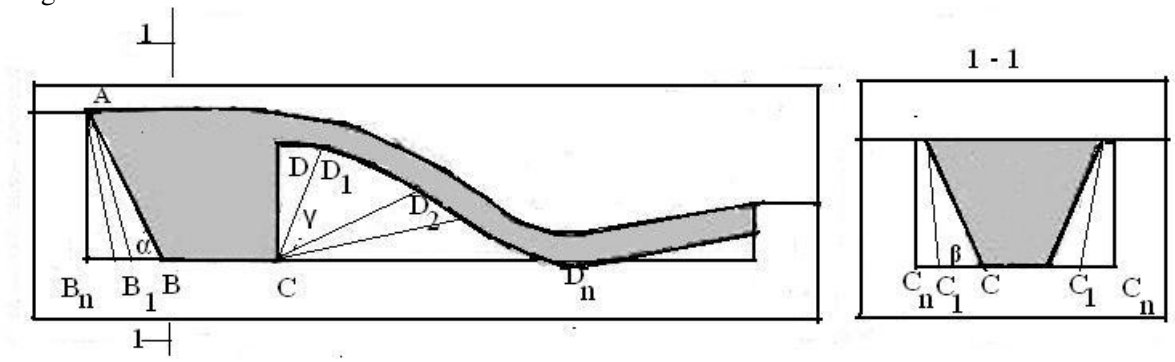

Fig. 1: *Diversification variants of the cavities by successive milling*

The question is if this mould can be used to obtain other sole models. Analyzing the possibilities, a set of solution has emerged. Multiple modification of the initial sole model can be obtained by modifying the heel shape. [3]. To obtain this, starting with a heel which forms at the back an angle α with the horizontal plane and an angle β to the sides, the mould can be modified by successive milling so that the points B and C will successively move to B_1, B_2,…, B_n respectively C_1, C_2,…, C_n. At the inside, which forms the angle γ with the horizontal, the point D can be successively moved to D_1, D_2,…,D_n. The edges that form the spatial shape of the heel can be straight or curved, obtaining multiple heel shapes with a straight or inclined front, up to orthopedic heel. A grate number of diversifications can be obtained by modifying the antiskid relief [4]. Also, by deepening successively the cavity of the mould, are obtained different thicknesses of the sole.

On the other hand, by modifying successively the mould, at some point, the cavity becomes cylindrical orthopedic. Returning to the conical shape of the heel is obtained by adding in the mould cavity of some metallic parts [5].

2.2. Solutions for obtaining moulds with modular cavities

In Figure 2, is presented a solution for manufacturing moulds which, by interchanging a set of modules, permits obtaining versatile cavities [6].

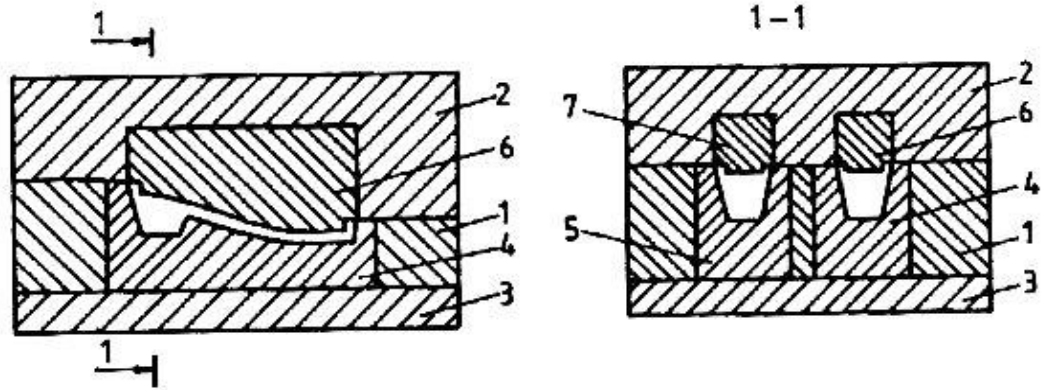

Fig. 2: *Mould with modular cavity*

1- base board; 2- cover board; 3- mount board; 4, 5- cavity forming modules; 6, 7 – weight removal cavities forming modules

It is noted that the mould is made of parts with dimensions that are not modified when changing the sole model and the replacing parts. The fixed pieces are on the base board and on the cover board, the cover board and the mount board. The parts that modify are the modules 4, 5, 6 and

7. In the base board are mounted the modules 4 and 5 that contain the cavities in which the soles are formed. The mount board is used for mounting the modules in the base boards and the entire assembly on the machine on which the mould is mounted. The cover board is similar to the ones used in classical moulds. In this board are mounted the modules 6 and 7 which form the weight removal cavities. This type of modular moulds is used in the case the soles have completely different models. There are situations in which it is not necessary to rebuild all the modules. If the weight removal cavities are not modified, the modules 6 and 7 are reused. If the sole shape is kept and only the antiskid relief or the side surface is modified, the modules 5 and 6 will be designed to allow the attachment of removable parts which will define the sole model [7].

3. EXPERIMENTAL

3.1. Producing modular cavities in existing moulds with unique cavities

The moulds with unique cavities, used for the manufacturing of the prefabricated soles, usually have a moulding board a sole plate and a cover plate. Closing the moulding board and the cover plate, the unique cavities will be generated.

A solution to obtain other models in this mould is to modify the cavity by successive mechanical processing by milling. In the obtained cavity are mounted the parts that will define the shape of the sole, the antiskid relief pattern and the side surface.

Through successive milling, at some point, the cavity becomes cylindrical-orthopedic. Producing some sole models in this type of cavity is possible by producing and mounting modules which have the cavity of the newly created sole model and parts for closing the remaining open cavity. The antiskid relief represents one of the main diversification criteria for the sole model. For this reason, it is recommended that the antiskid relief to be engraved on parts that will be mounted in this module. By using this kind of modules, in some conditions, can be obtained even soles with size numbers smaller than the size number for which the mould was initially manufactured. This kind of solutions is presented in Figure 3.

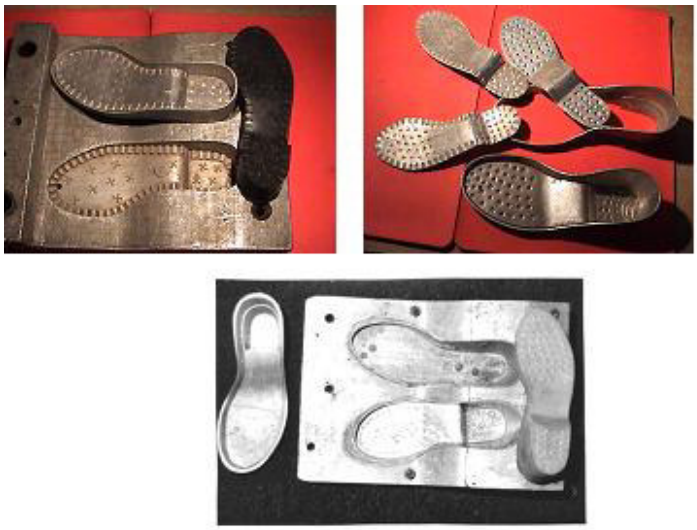

Fig. 3: *Modules for cavity forming in moulds with unique cavities*

3.2. Manufacturing moulds with modular cavities

The structure of the mould in which can be formed multiple sole models, is different than the moulds with unique cavities. A versatile mould [8], modular cavities is represented in Figure 4.

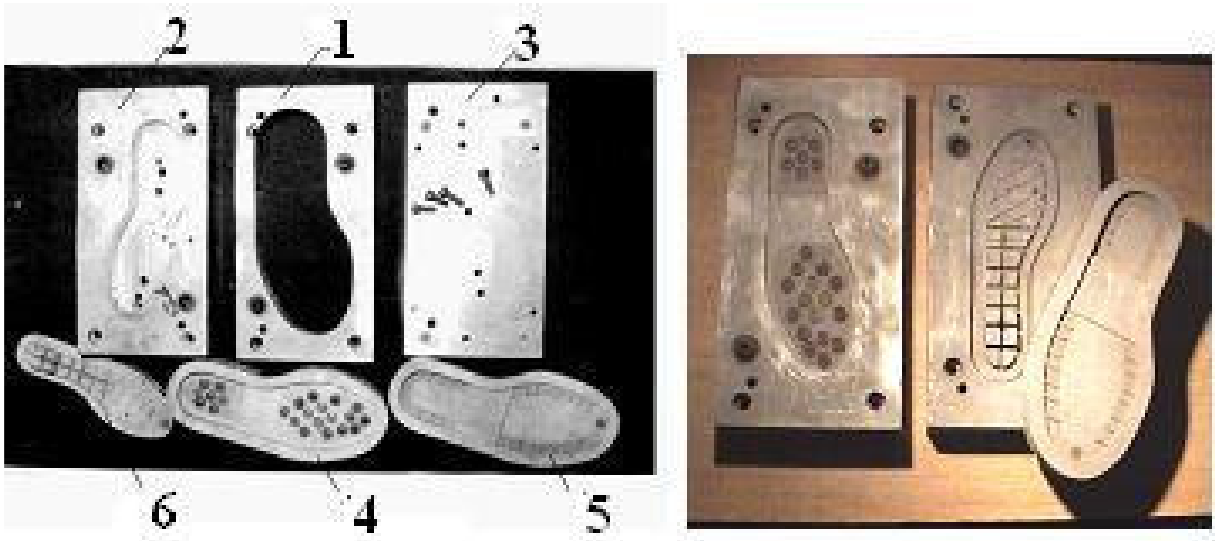

Fig. 4: *Parts of the mould with modular cavity*
1 - base board; 2- cover board; 3- mounting board; 4, 5 – cavity forming modules; 6 – cavity forming module

The mould is formed by a base board, a cover board, a mounting board and a set for modules. To simplify the manufacturing, the mould has only one cavity. In the base board is mounted the module that forms the cavity. The assembly of base board and cavity module is fixed on the mounting board which will serve for mounting the machine too. In the cover board is fixed the module that will close the cavity and that will form the weight removal cavities [9]. In Figure 4 is presented the mould and after mounting the main pieces and the modules. It is noted that the modules that form the cavity and the weight removal cavities are interchangeable [10]. In the Figure 5 are presented the modules and the soles resulted by injection.

Fig. 4: *Mould with assembled modular cavity*

Another mould with modular cavity in which are obtained pairs of soles, is presented in Figure 5.

Fig. 5. *Mould with two modular cavities*

4. RESULTS AND DISCUSSIONS

Obtaining modular cavities by successive modifications of a cavity with unique shape have highlighted a series of aspects like:

- The shape diversification of the soles by gradually modifying a cavity is limited. Depending on the initial shape of the cavity and the sole models that are requested, it is possible to rapidly achieve the limit situation when the heel has a cylindrical orthopedic shape.
- A larger diversification of the sole models in a mould with a given cavity can be obtained by the antiskid relief characteristic and the side surface. In this case the shape and volume modifications should be avoided.
- The reversed operation, of obtaining modular cavities by mounting pieces in the cylindrical orthopedic cavity, has advantages in the cases of diversification by antiskid relief and side surface model too.
- Including this kind of moulds in the current production activity implies the often rebuild of the pieces and modules that define the cavities. Therefore, this kind of moulds is efficient in the case of small sole production like: producing the collection for market analysis; producing unique sole models; obtaining model diversification by antiskid relief, keeping the main shape and the volume of the sole.

The manufacturing and experimentation of some moulds with versatile cavities lead to the following findings:

- These moulds allow, by the interchangeability of some modules, the forming in the same mould of cavities in which can be obtained a great diversification of the sole models.
- By their structure mode, the moulds are made of parts with fixed shapes and dimensions, whatever the modifications made on the cavity.
- The mounting and dismounting the parts of the mould to achieve the cavity modification can be easily made without risking the modification of their quality.
- Preserving the initial shape and volume of the soles, a great number of model diversification can be achieved with low costs only by modifying the antiskid relief. In this case, the modules that form the cavity are preserved and only the pieces that define the antiskid relief are rebuild.
- The weight removal cavities of the soles have the role of making the soles lighter and are not diversification criteria for the models. The same modules used for weight removal cavities can be used on a large number of sole models.
- The soles obtained in this type of moulds are similar from the quality point of view, to the soles formed in moulds with unique cavities.
- The moulds with versatile cavities are obtained by the same technologies as the moulds with unique cavities. The same technological parameters apply and are mounted on the same type of machines. These moulds and the classic moulds can be used simultaneously.

5. CONCLUSIONS

- The moulds with modular cavities can be manufactured faster and with smaller costs then the moulds with unique cavities. This has as an immediate effect the faster launching into production and on the market of mew sole models and with smaller prices.
- The production of moulds with versatile cavities for obtaining new soles, highlighted the decreasing of the production time and costs with 20% up to 80% in relation with the manufacturing of new moulds with unique cavities having the same destination. This fact is possible because a part of the mould pieces are reusable. The economy is much more visible when producing an entire new set of moulds for a new model of sole.
- The efficiency of using moulds with versatile cavities can be emphasized also by other factors of which we can enumerate: reducing the costs of the materials; reducing the costs of the energy; reducing the necessary of work force; reducing the salary direct costs; increasing the profit, etc.
- By producing a smaller number of moulds with versatile cavities, even one single piece, soles with different models and of different polymeric blends can be obtained, to experiment new polymeric blends or for marketing studies.
- The moulds with versatile cavities can be used to obtain multiple sole models till the physical outworn, minimizing the lost caused by the moral outworn.
- Introducing in the sole fabrication process of moulds with versatile cavities, as the only solution or in conjunction with the classic moods, opens new perspective in this domain.

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