WEAR OF MOLD PUNCHES FOR VIBROPRESSED PAVES

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Abstract: *The paper aims to determine the degree of wear of the punches of a mold for vibro-pressed pavers. Wear of the mold core and/or punches directly affects the shape, dimensions and quality of the pavers. The wear of the edges of the punches influences the contour of the pavers and leads to the appearance of a surface defect through a surplus of material on the edges of the pavers.*

Keywords: die, punch, wear

1. Introduction

Wear is a process of destruction of the surface layer of a solid body upon mechanical interaction with another solid body, with a fluid or with a fluid with solid particles in suspension. This process takes time and is often accompanied by significant material loss.

Abrasion wear is caused by the presence of hard particles between the contacting surfaces. It is easily recognized by the tracks oriented in the direction of movement. This wear manifests itself both in the form of plastic deformations and detachments of metal microparticles, as well as in the form of micro-chips.

In the contact zone, a process of sliding of the particle and deformation of the surface takes place. The presence of the relative movement of the particles and their repeated action on the surface cause wear particles to appear in the contact area, gradually changing the shape of the surface, so that after a certain time the surface is taken out of service.

2. Methodology for measuring punch surfaces

To measure the surfaces of the punches, a NIKON coordinate measuring machine is used Figure 2.1.

To perform the measurements, the following steps must be completed:

- the feeler is brought into contact with the punch (direct contact);
- the coordinates of the measured point are recorded and compared with the coordinates of the same landmark point, establishing the deviation;
- by moving the feeler on the surface of the punch, its roughness can be determined.

Figure 2.1. *NIKON coordinate measuring machine*

3. Experimental results and discussion

To study the wear of the punches for the molds used in concrete vibropresses, the production of pavers (210x140x60mm) obtained with the help of the SYMM04 mold is considered, Figure 2.2.

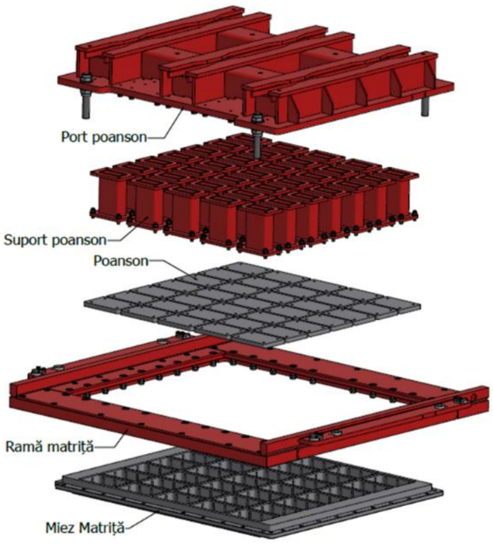

Figure 2.2. *SYMM 004 die*

Considering a punch to have the initial shape as in Figure 2.3, the worn punches of a die after 58,000 operating cycles were studied.

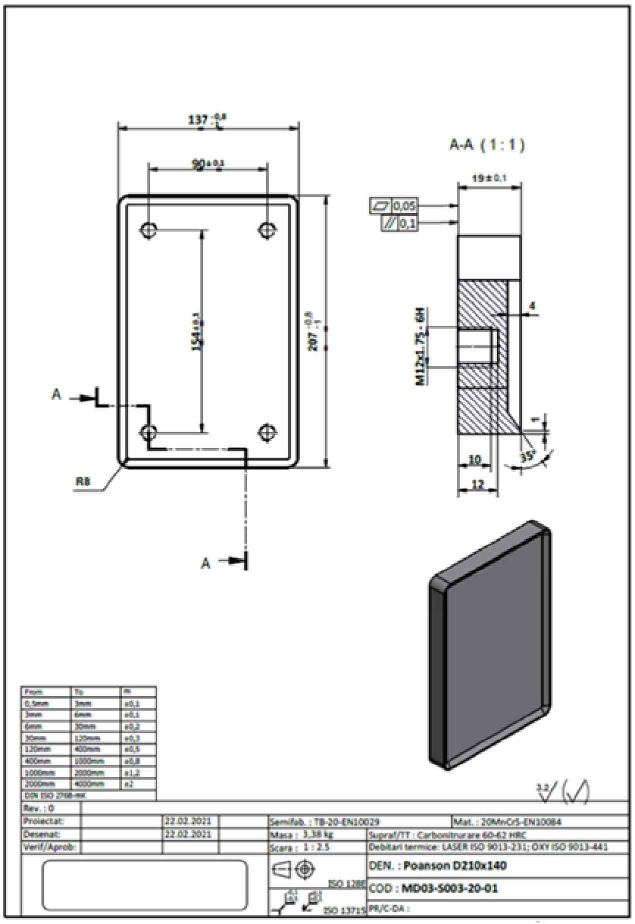

Figure 2.3. *Punch execution drawing*

3.1. Punch surface measurement

Measurements were made of the surface of the punch at elevation 15 (Figure 2.3), at points 1, 2, ..., 12, (Figure 2.4).

Figure 2.4. *12 measurement points*

Measurement values for the 12 points of interest on a new punch and three other mold punches were recorded in Table 2.1.

With the help of these values (in micrometers) the graphs Figures 2.5 could be drawn. – 2.16.

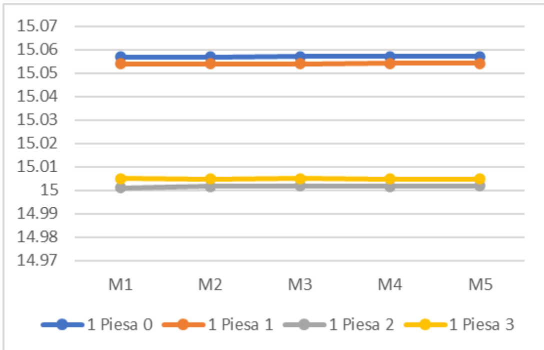

Figure 2.5. *Measurements taken in point 1*

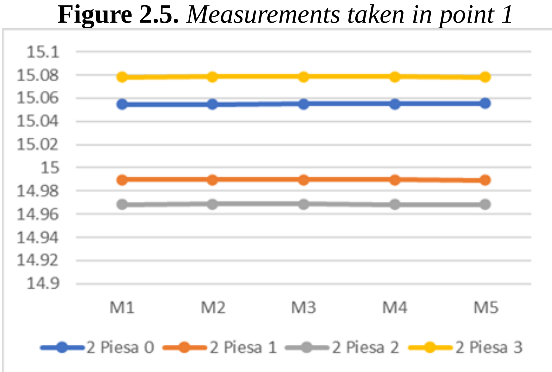

Figure 2.6. *Measurements taken in point 2*

Table 2.1 *Measurements of the surface of the punch at level 15*

piesa·0·noua												
cota·	Pct·1	Pct·2	Pct·3	Pct·4	Pct·5	Pct·6	Pct·7	Pct·8	Pct·9	Pct·10	Pct·11	Pct·12
	15.0570	15.0551	15.0810	15.0514	15.0705	5.1000	15.0427	15.0670	15.0780	15.0267	15.0326	15.0467
	15.0569	15.0551	15.0815	15.0516	15.0707	5.1002	15.0423	15.0671	15.0780	15.0266	15.0324	15.0466
15.0	15.0572	15.0552	15.0813	15.0516	15.0706	5.1002	15.0427	15.0673	15.0782	15.0267	15.0326	15.0468
	15.0571	15.0552	15.0813	15.0516	15.0707	5.1004	15.0426	15.0675	15.0782	15.0266	15.0326	15.0468
	15.0572	15.0553	15.0813	15.0517	15.0706	5.1004	15.0424	15.0672	15.0780	15.0264	15.0329	15.0469
piesa·1												
cota·	Pct·1	Pct·2	Pct·3	Pct·4	Pct·5	Pct·6	Pct·7	Pct·8	Pct·9	Pct·10	Pct·11	Pct·12
	15.0541	14.9896	15.0113	14.9868	14.9565	14.9639	14.9898	14.9875	14.9788	14.9672	14.9761	14.9832
	15.0541	14.9897	15.0116	14.9867	14.9564	14.9636	14.9900	14.9874	14.9786	14.9670	14.9765	14.9835
15.0	15.0541	14.9895	15.0116	14.9867	14.9565	14.9634	14.9899	14.9875	14.9787	14.9670	14.9767	14.9834
	15.0542	14.9896	15.0114	14.9869	14.9563	14.9635	14.9898	14.9875	14.9788	14.9673	14.9766	14.9835
	15.0542	14.9894	15.0112	14.9869	14.9563	14.9638	14.9899	14.9877	14.9791	14.9674	14.9765	14.9832
piesa·2												
cota·	Pct·1	Pct·2	Pct·3	Pct·4	Pct·5	Pct·6	Pct·7	Pct·8	Pct·9	Pct·10	Pct·11	Pct·12
	15.0010	14.9685	14.9542	15.0110	14.9643	14.8455	15.0210	15.0193	14.8702	14.9720	15.0363	15.0013
	15.0016	14.9688	14.9539	15.0107	14.9640	14.8449	15.0212	15.0194	14.8701	14.9716	15.0366	15.0006
15.0	15.0019	14.9686	14.9540	15.0107	14.9640	14.8451	15.0213	15.0194	14.8704	14.9711	15.0366	15.0010
	15.0017	14.9685	14.9542	15.0160	14.9637	14.8449	15.0214	15.0195	14.8702	14.9713	15.0364	15.0017
	15.0020	14.9683	14.9542	15.0160	14.9635	14.8448	15.0214	15.0194	14.8700	14.9726	15.0362	15.0013
piesa·3												
cota·	Pct·1	Pct·2	Pct·3	Pct·4	Pct·5	Pct·6	Pct·7	Pct·8	Pct·9	Pct·10	Pct·11	Pct·12
	15.0050	15.0784	14.9881	15.2667	15.3557	15.3290	15.2917	15.3536	15.3387	15.0354	15.0493	15.0780
	15.0049	15.0785	14.9880	15.2671	15.3557	15.3290	15.2920	15.3535	15.3388	15.0356	15.0496	15.0774
15.0	15.0050	15.0785	14.9880	15.2670	15.3558	15.3280	15.2921	15.3533	15.3388	15.0356	15.0497	15.0777
	15.0049	15.0785	14.9880	15.2673	15.3560	15.3276	15.2920	15.3535	15.3379	15.0358	15.0496	15.0774
	15.0048	15.0784	14.9880	15.2672	15.3559	15.3740	15.2921	15.3533	15.3375	15.0358	15.0495	15.0776

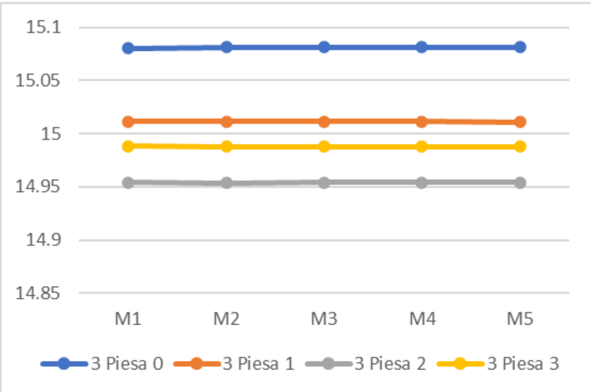

Figure 2.7. *Measurements taken in point 3*

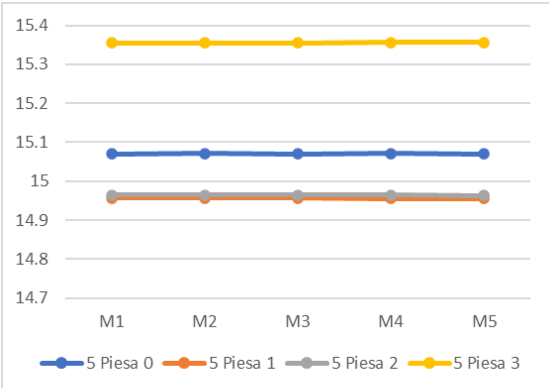

Figure 2.9. *Measurements taken in point 5*

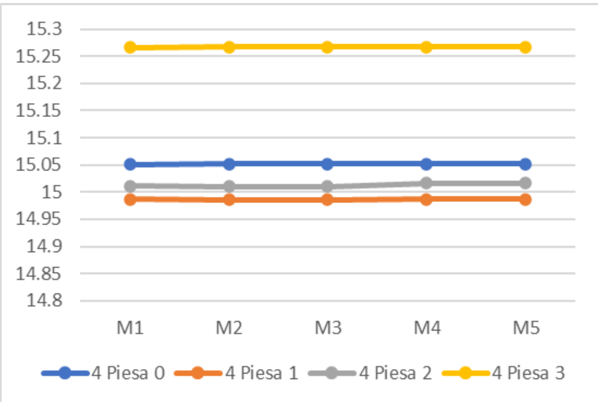

Figure 2.8. *Measurements taken in point 4*

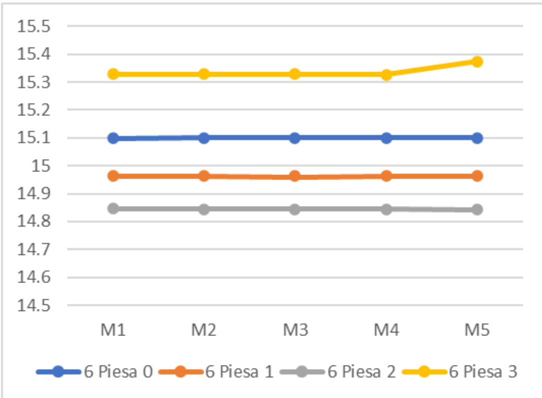

Figure 2.10. *Measurements taken in point 6*

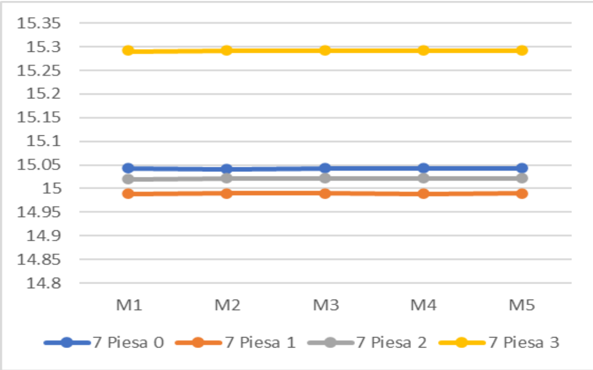

Figure 2.11. *Measurements taken in point 7*

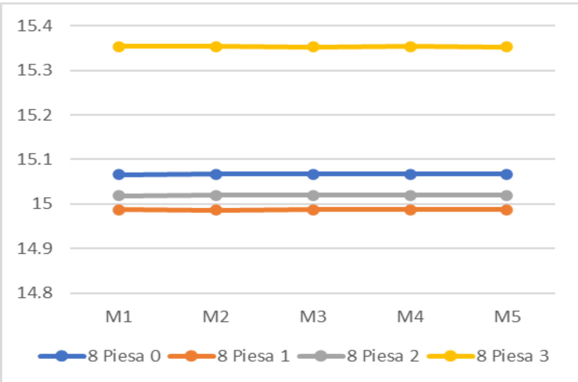

Figure 2.12. *Measurements taken in point 8*

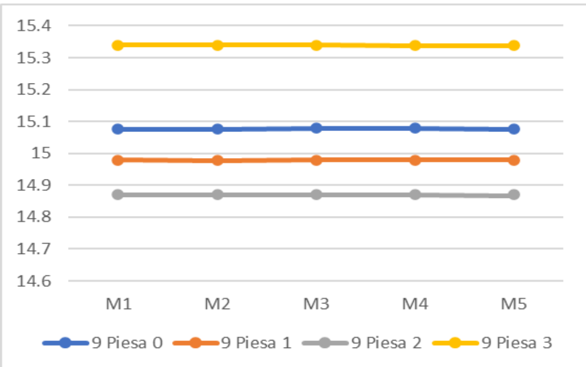

Figure 2.13. *Measurements taken in point 9*

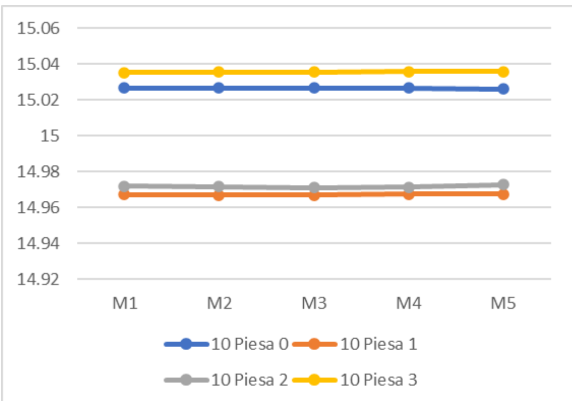

Figure 2.14. *Measurements taken in point 10*

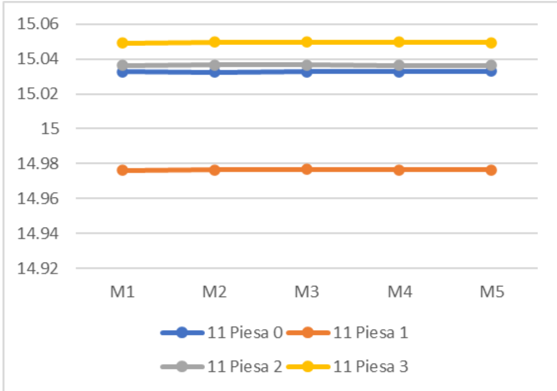

Figure 2.15. *Measurements taken in point 11*

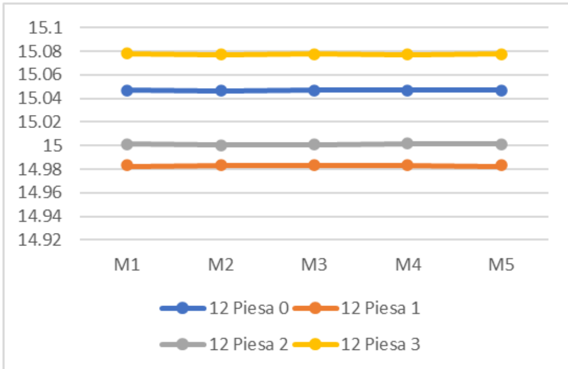

Figure 2.16. *Measurements taken in point 12*

It can be found that the abrasion wear was mainly caused by the presence of abrasive particles between the contacting surfaces which led to microchilling of the edges (missing material of the order of tenths of mm) and detachment of the material in the form of pinches. Note the more pronounced wear of part 3, for all measurement points.

3.2. Measuring the contour of the punch

The punch outline was measured in 14 points positioned as in Figure 2.17.

Figure 2.17. *Punch contour measuring points*

The contour measurement is carried out according to Figure 2.18.

Figure 2.18. *punch contour measurement*

After measuring the contour of the punch (6 punches), Figure 2.19, with the help of the data from Table 2.2, the contour profile is graphically represented in the 14 measurement points.

The friction process that occurs in operation between the punch, the mold and the interposed material (mixture of stone aggregates with different granulations, sand and cement) has the effect of physical wear, which consists in detaching the material and changing the initial state of the surfaces in contact, changing size, geometric shape and surface roughness of superficial layers.

Abrasion wear damages the surface of the punch and die core which has a direct effect on the quality of the finished product. Pavers with various surface defects can thus be observed such as pinches, missing material, small irregularities on the surface of the products, which can be detected by touch, edges with uneven surfaces, microcracks, etc., Figure 2.20.

Table 2.2 *Measurements of punch surface*

	Latura·superioară			Latura·inferioară			Latura·lateral·dreapta				Latura·lateral·stânga			
	puncte			puncte			puncte				puncte			
piesa	Pct·1	Pct·2	Pct·3	Pct·4	Pct·5	Pct·6	Pct·7	Pct·8	Pct·9	Pct·10	Pct·11	Pct·12	Pct·13	Pct·14
1	3.0962	3.2568	3.0866	3.0384	3.1098	3.0282	3.4264	3.6536	3.6771	3.3242	3.3918	3.5617	3.5776	3.4192
2	3.2054	3.2555	3.1364	3.2479	3.2276	3.0656	3.6971	3.8938	3.8760	3.8210	3.3991	3.6442	3.7849	3.6803
3	3.6476	3.6257	3.4108	3.5714	3.6107	3.3826	3.7423	3.6017	3.5816	3.7511	3.7762	3.8422	3.8469	3.8265
4	3.1605	3.2376	3.0022	3.2483	3.1942	3.0355	3.6891	3.8660	3.8044	3.7933	3.2506	3.6547	3.766	3.6637
5	3.8059	3.8160	3.8317	3.8206	3.8880	3.8301	3.2242	3.3305	3.4448	3.3383	3.2251	3.2850	3.1191	3.2038
6	3.5847	3.7072	3.6447	3.4762	3.6173	3.5447	3.8158	3.8535	3.9055	3.9572	3.8817	3.8169	3.7352	3.7034

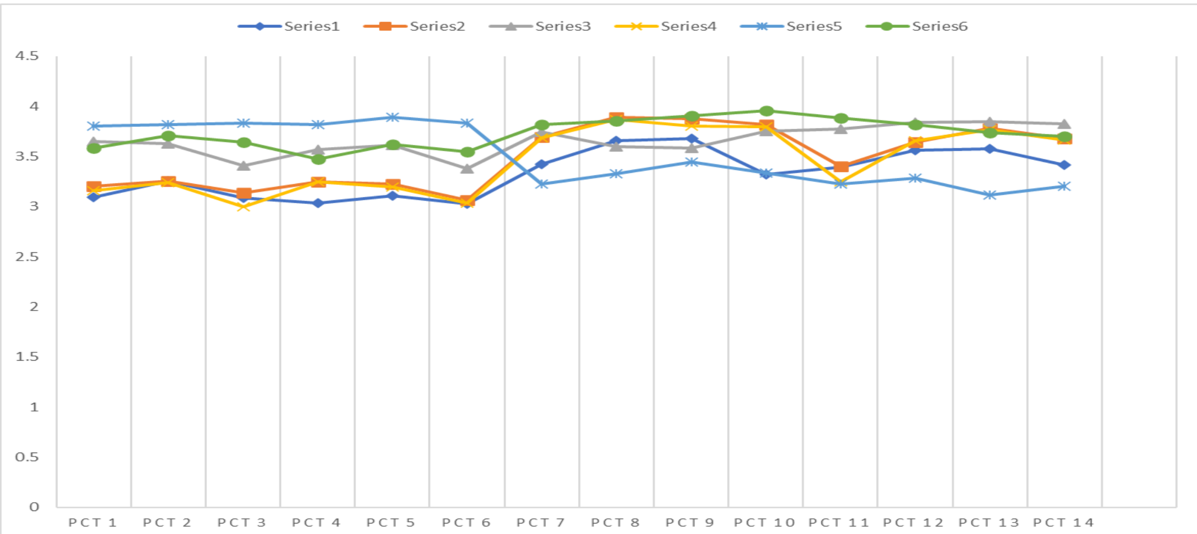

Figure 2.19. *The contour of the punch in the 14 measurement points*

Figure 2.19 shows a non-linear variation of all 14 measurement points for the 6 punches.

Figure 2.20. *Contour defects of the punch*

The measurement on the micro geometric scale of the height variations of the punch is carried out with the help of the portable roughness meter SJ-210 [mm] "R2µm; 0.75mN" Mitutoyo 178-560-13, Figure 2.21.

It is noted that the evaluated profiles can be drawn.

Figure 2.21. *Measurement with the portable roughness*

4. Conclusions

The quality of small semi-dry concrete prefabs (pavers, slabs, curbs, etc.) is influenced by:

- the quality and type of rock and sand aggregates;
- the experience of the vibropress operators;
- mold quality;
- wear of the mold core and punches.

The quality and type of aggregates as well as the experience of the vibro-press operators are closely related to each other.

Although there is a well-established recipe for each type of prefab (depending on thickness, dimensions, type of product, etc.), the final quality of the products is given by the knowledge of the aggregates that are made available and the corrections that must be made to the recipe (the aggregates they don't come with the same moisture every time, and even if there are sensors to read the moisture of aggregates or cement, small corrections are needed by the operator).

An average operator gets to know the machine after at least a year or two of daily practice.

Regarding the mold, there are several defining elements that form the basis of making a mold that gives the products a complete configuration and precise dimensions.

The execution process of a mold is quite complex, and the duration can vary between 1-3 months.

The mold core and the punches are the most sensitive elements of the construction because they support both high-precision mechanical processing, with strictly tolerated dimensions, and heat treatment operations to enrich the superficial layer of the surfaces, which are executed in collaboration with third parties.

The machining process on MUCNC is well established and controlled. The mold core is checked on the 3D coordinate measuring machine in the CTC laboratory, but the same control cannot be performed for the surface hardening process at a third-party company. This is where the first problems arise in the mold making process: the mold core returns from heat treatments with defects due to errors in placing the core in the oven or not following the treatment diagram (surface flatness deviations of up to 7 mm) which also leads to the deviation of the nest's perpendicularity to the surface, dimensional deviations on the diagonal of up to 5 mm, taking into account that the accepted deviations are ±1 mm. The operation of returning a deformed core to its parameters involves heating in the oven to a temperature of 220-230°C and holding for a well-determined period of time, followed by a cold plastic deformation operation at that temperature and holding in fixed fixtures until upon complete cooling. It is obvious that not every time it is possible to recover the core completely, sometimes it is necessary to launch another semifinished product. One of the disadvantages of this procedure is the presence of internal stresses remaining inside the core that are transmitted to the assembly members (especially screws) during the assembly phase of the core in the mold frame. The result is a mold with internal stresses that propagate with each casting cycle and often lead to sectioning of set screws and breakage of mold components.

Wear of the mold core and/or punches directly affects the shape, dimensions and quality of the pavers. The wear of the edges of the punches influences the contour of the pavers and leads to the appearance of a surface defect through a surplus of material on the edges of the pavers. Damage to the walls of the mold nests leads to changes in the overall dimensions of the prefabs, lack of parallelism between the side surfaces, or lack of material.

During the assembly phase, the punches are fixed in the nests with the help of spacers, and the punch holder is placed on top of the punches and fixed by means of assembly elements, in the form of a single assembly, keeping a tolerated play of 0.2 - 0.3 mm between the punch and the die nest. When the mold is fixed on the vibropress, most of the time it is not possible to ensure the uniformity of this play on all sides of the punch, which leads to premature wear of some edges of the core and the punch.

To improve the quality and accuracy of cast products, the following aspects should be taken into account:

- when designing the mold, the designer must take into account the technical requirements of the mold, and the structure must comply with the feasibility criteria of its manufacture, taking into account its rigidity and resistance in the established period. It is also preferable that the corners of the surfaces of parts and welded subassemblies are designed as rounded transitions, not at right angles, to avoid stress concentration;
- it is necessary to improve the process of processing the component parts of the mold, taking into account that the processing precision of each landmark or subassembly directly affects the assembly of the mold;
- achieving a strict quality control of the carbonitriding process;
- the organization of trainings or professional training courses for mechanical locksmith mold assembler, so that certain aspects related to the precision of assembly execution are fully mastered or other new knowledge can be assimilated, taking into account the market requirement for new products ;
- the provision of a mounting scheme and/or the design of some devices of the mold on the vibropress to balance and guarantee the preservation of a continuous minimum play along the contour of the mold nests.

References

1.GAFITANU, M. s.a. Organe de mașini, vol. II. București, Editura tehnica, 1983

2. PAIZI, Gh. s.a. Organe de Mașini și mecanisme. București, Ed. Didactica si pedagogica, 1977

3. MLĂDINESCU, T. Organe de mașini și mecanisme, București, Ed. Didactica si pedagogica, 1972

4. CIOC, I., Catrina, N. CRISTEA N., Tehnologia fabricării, întreținerii și reparării mașinilor, Ed. Didactica si Pedagogica, București 1977

5.https://www.google.com/search?rlz=1C1GCEA_enRO953RO953&q=KVM+VIBROPRESA&tbm=isch&sa=X&ved=2ahUKEwixhff_uc__AhX2yAIHHevdC1wQ0pQJegQICxAB&biw=1280&bih=625&dpr=1.5#imgrc=i0wo_nlkh9ZcAM accesat la 10/06/2023

6.https://www.symmetricatech.ro/produse/echipamente-industriale accesat la 20/05/2023

7.https://www.vigra.ro/catalog/masurare-rugozitate-127 accesat la 10/06/2023

8.https://www.ttonline.ro/revista/calitate-control/nikon-metrology-masini-de-masurat-in-coordonate-cu-precizie-ridicata-si-dimensiuni-extinse accesat la 10/06/2023