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EXPERIMENTAL MEASUREMENT OF PRESSING FORCE OF THE WORKING PROCESS OF THE WORKPIECES FROM LAYERED WOOD

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ABSTRACT
Modelling technique of layered pieces of wood (veneer), bending and simultaneously gluing with VF electricity, is a complex technological process, in which is very difficult, theoretically, using analytical models, reliably determine the processing parameters such as contact pressure, load tools , deformation phenomena in the workpiece and the tool, friction, etc. This paper presents an experimental procedure for determining the pressing forces in order to obtain adequate contact pressure on the workpiece with varying parameters: the structure, the angle and the type of glue. Also they are shown with measurements of obtained results in the formation of axisymmetric workpieces, which can serve as a basis for developing new and for improving existing working processes and systems.
Keywords: pressing force, axisymmetrical workpiece, experimental measurement,

1. INTRODUCTION

It is known that if we try to reflect the wood in natural state in desired shape, where the thickness of the used workpiece is large, and the bending radius is small then it will surely come to the damage that is intolerant. Wood bending belong among the most important processes of shaping the details of furniture. We define wood bending as a process by which the initial flat shape of the rough or pure workpiece (solid or thin wood -veneer) gets three-dimensional body, most common to this shapes: «U», «V», «L», etc. In the wood-industrial practice we encountered simple and complex shapes of bent workpieces, but regardless the shape complexity of shaping process with bending procedure laws of plastic deformation of wood must be obeyed. In modern design furniture manufacturing there is often a need for curved details made of wood, for thicker wood with smaller radius of curvature, and at the same time there is a need for wood strength that matches the conditions of use. For these reasons, have developed many technological processes that enable bending of thick detail of wood into smaller radii of which are now commonly applied the following two:

1. Wood softening, and than bending and
2. Simultaneously bending and gluing thin wood pieces (veneer).

Which of these two procedures should be applied depends on several factors such as thickness and radius of curvature, type of wood, structural strength and aesthetic appearance of details (depending on its position and role in the product), etc. In both cases it is a plastic deformation where the goal is to get the desired configuration detail, and at the same time to avoid breaking local material and geometric inaccurate. In this paper, we restrict to the formation of axisymmetric workpieces from layered wood (veneer), with bending process and simultaneously gluing with high frequency heating with electricity, and ultimately from them the details of furniture will be made. To get the desired quality glued workpiece shape and at the same time avoid negative phenomena: the geometric clarity, the local tearing of materials, low strength, etc., it is necessary to design shaping process of materials to follow the development of deformation corresponding to the combination ratio of the principal strains and

simultaneously provide a complete gluing between the contact surfaces in the glue which will be evenly deployed. One of the important factors for good bonding is the contact pressure that is achieved for a particular case by determining the intensity of the force which acts on the press tool design. Difficulties that limit the production of curved details can be partially or completely eliminated if we execute the analysis of technical and technological parameters of the process, if we apply scientific methods with the aim of modelling and defining the optimal conditions of machining processes and systems, and then on that basis technologically shape and design the modern treatment processes.

2. THEORETICAL ANALYSIS OF PRESSING WORKPIECE FROM LAYERED WOOD

In the process of designing the curved size pieces of layered wood with pressing, where the gluing is done at the same time, it is very important to correctly determine the direction, route, schedule and intensity of pressing force. Uniformly activity of the pressing force on curved surface result with contact pressure that are in the range of: : q*max = q* to q*min = 0,* depending on the size of the central angle α, Figure 1. Special attention must be given to stiffness of the shaping tool and position of the working elements of the machine that produces and together with the parts of tools transfer necessary force. Also, when it comes to the position of the workpiece in the pattern, as a main part of the tool should pay attention that the direction of resultants of all forces acting on any axisymmetrical or asymmetrical workpiece during gluing, be directed on the upper surface of bottom plate of press, Figure 2.

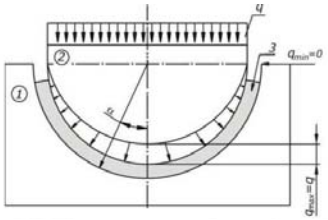

Figure 1. The pressure at the surface of axisymmetrical workpiece [5] (1-matrice, 2 - patrice; 3-workpiece;)

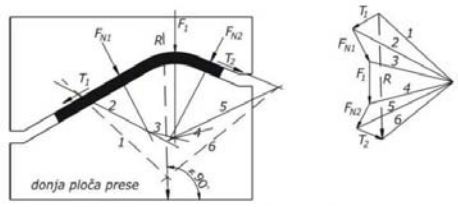

Figure 2. The position of the workpiece in the pattern [1]

In determining the direction of the resultants R we must pay attention on the intensity of all the forces that occur as a result of external pressure. It means that when determining the position of resultants we must count with the forces that originate from the action presses (F) and with the forces of friction that originate from friction between the surface of the pattern and the workpiece(T). They are calculated through the coefficient of friction, which according to [1], is: 0.3 ÷ 0.4. The intensity of the resultants is determined analytically, and its direction graphically, Figure 2. and conditioned by the technological order, under which are carried out technological operations. Irregular course and direction of the pressing force can lead to poor quality of gluing and intolerant strain of the workpiece and shaping tool. When performing technological operations of pressing-modelling design, which includes the heating of high frequency electricity current intensity of the pressing force is defined by the contact pressure. Orientation values of these pressures, for different types of gluing are given in tables in [1]. While calculating it is given a minimum contact pressure (p_{min}) in critical points and than we can calculate maximum (Figure 1.), with expression from [1]:

$$p_{min} = p_{max} \cos \alpha \qquad \ldots(1)$$

Based on the known surface bonding (A) and maximum contact pressure (p_{max}), can be calculated to determine the intensity of the pressing force (F) according to:

$$F = p_{max} \cdot A \qquad \ldots(2),$$

In addition to the forces pressing for good gluing of pieces with curved shapes, particular attention should be given to: the high accuracy of pattern (mold) as a basic part of the tool and the realization of sufficient external pressure on the critical places.

3. EXPERIMENTAL MEASUREMENT OF PRESSING FORCE

For the experimental measurement of pressing force, was chosen axisymmetrical workpiece from layered wood figure 3. According to the parameters of the workpiece, with calculations [1], are

obtained parameters of shaping tool, then the workpiece and the tool with the help of computer graphics are presented in 2D, Figure 3. and in a full 3D models, Figure 4. After the definition, analysis was performed using the FME model and performed the simulation of loads such as model tools , together with the model of the workpiece Figure 3. subjected to loads, what awaits him in future production, to examine his conduct preventive -rigidity. When it is determined that the tool has satisfactory stiffness, it has been designed and constructed in accordance with the prepared technical documentation. Also is selected a hydraulic press TIPE: PHF-100, manufactured by "ITALPRESSE" Italy, with four working piston 100 mm diameter each, placed under the lower desk. Lower desk moves bottom-up and the top is fixed, Figure 5.

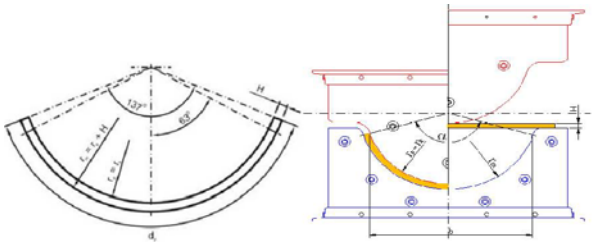

Figure 3.The basic model of the workpiece and tool design[5]

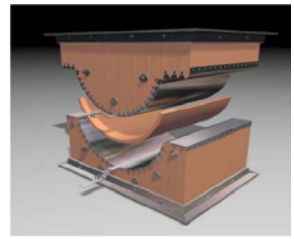

Figure 4.3D full model of tools and workpiece[5]

Since the resultant of press force which is acting on the tool is created as a result of four pistons, performing experimental measurements was carried out as follows:
- the tool is placed between the upper and lower work table presses, the center of the tool (also dies, patrice and the workpiece), and work tables match in all areas,
-patrice, in the predetermined position on the steel plate on which are symmetrically located four dynamometer with tensor strips, tied for the top table of press, using the set screws so that they can be with its leveling and slight movement up and down, during loading and unloading (Figure 6).

Figure 5. Hydraulic presse with generator of VF- electricity [5]

Figure 6. Location of patrice

Figure 7. Dynamometers for measuring press force[5]

- matrice is also using delimiters bound to the upper press desk,
- after setting up tools in the press, with four dynamometer, Figuure 6. and 7., associated with the computer, Figure 8. b). and with the help of test pieces, it is accessed to checkingintensity of pressing force and the endurance of the tool, or the whole system (Figures 8. and 9.).

During these activities the system is slowly loaded and at the end with pressing force, which intensity according to the expression (2) for a particular case is: 355.25 kN. After that it was possible to access the measurement of the total pressing force during the sixteen experiments. The goal was that in the real terms, except checking the behavior and durability of special tools in the entire system, simultaneously obtain uniformly the total force deployed on the tool presses and four symmetrically placed measuring points, which is a precondition for achieving the required contact pressure and obtaining quality of glued workpiece.. The purpose of measuring device were used to measure and reinforce and the computer (Figure 8. a) and b)) by which was read and registered intensity of press force for each experiment. Component values of pressing force (F_1; F_2; F_3 *i* F_4 *in (kN)*) measured in forpoints , are directly written on computer, and their sum represents total pressing force (*Fp*), Tab. 1.

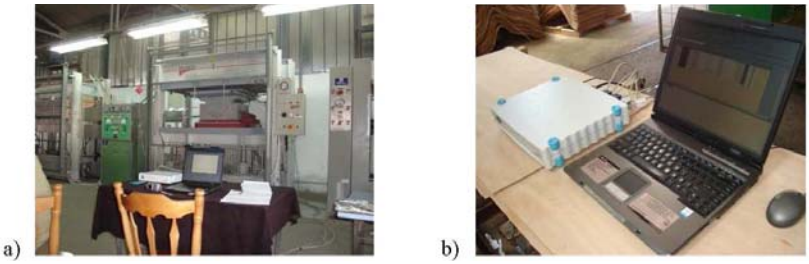

Figure 8. A device for measuring the amplitication and computer[5]

Table 1. Measurement results [5]

Experiment	F_1	F_2	F_3	F_4	F_p	*Experiment*	F_1	F_2	F_3	F_4	F_p
E1	*91,4*	*88,2*	*80,7*	*92,4*	*352,7*	*E9*	*87,0*	*89,4*	*83,9*	*95,3*	*355,6*
E2	*87,8*	*89,6*	*84,6*	*92,1*	*354,1*	*E10*	*90,0*	*92,5*	*84,5*	*94,1*	*361,2*
E3	*86,6*	*87,3*	*83,4*	*93,4*	*350,7*	*E11*	*87,5*	*89,6*	*82,2*	*92,1*	*351,4*
E4	*88,2*	*87,1*	*80,7*	*92,3*	*348,3*	*E12*	*88,7*	*89,2*	*85,1*	*96,1*	*359,1*
E5	*91,1*	*91,8*	*84,8*	*95,7*	*363,4*	*E13*	*87,7*	*91,9*	*83,5*	*91,2*	*354,3*
E6	*89,3*	*91,6*	*84,3*	*93,6*	*358,8*	*E14*	*88,8*	*94,4*	*84,6*	*93,9*	*361,7*
E7	*84,5*	*92,1*	*85,2*	*91,3*	*353,1*	*E15*	*84,8*	*89,9*	*83,5*	*94,1*	*352,3*
E8	*86,8*	*91,9*	*84,5*	*93,0*	*356,2*	*E16*	*83,8*	*90,4*	*82,5*	*89,6*	*346,3*

Based on the measured values were obtained diagrams of pressing force for each experiment, as in Fig 9. and 10.

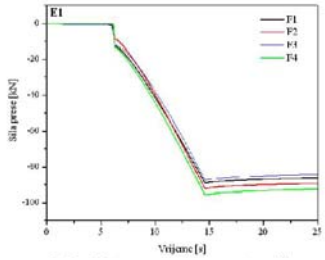

Figure 3.7. Measured pressing force (E1) [5]

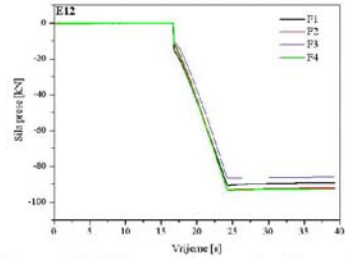

Figure 3.8. Measured pressing force (E12)[5]

During the measurements input parameters were varied: structural workpiece "K", the angle α and the type of glue, "G," and veneer packages for every workpiece were prepared according to the plan of the experiment, just before investing in the press.

4.CONCLUSION

With experimental measurement of pressing force were obtained results that reflect the real condition of the pressing process of selected axisymmetrical workpiece from layered wood on the press which transfer the pressing force through four pistons. Analyzing the results of experimental measurement, together with other technical and technological parameters of modelling process, using the scientific methods it is possible to model and define the optimal conditions for working process and thus achieve the ultimate goal, which means, to increase productivity, efficiency, quality and lower cost per unit of product.

5. REFERENCES

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