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INFLUENCE OF PARTICLE SIZE IN THE SANDING PROCESS OF *PINUS ELLIOTTII* WOOD

Francisco Mateus Faria de Almeida Varasquim
Manoel Cléber de Sampaio Alves
Universidade Estadual Paulista/UNESP, Itapeva, São Paulo, Brazil.
manoel@itapeva.unesp.br

Marcos Tadeu Tibúrcio Gonçalves
Universidade Estadual Paulista/UNESP, Itapeva, São Paulo, Brazil.
tadeu@itapeva.unesp.br

Demétrio Zacarias
Universidade Estadual Paulista/UNESP, Itapeva, São Paulo, Brazil.
demetriozacarias@gmail.com

Paulo Roberto Gomes Alves
Universidade Estadual Paulista/UNESP, Itapeva, São Paulo, Brazil.
gomespaulo13@yahoo.com.br

Abstract. *Wood sanding is extremely important to ensure the quality of the wood surface. Nevertheless, this process is still done empirically in many places and there are still many variables to be analyzed for total control of the process. In this paper was evaluated the surface quality of the Pinus elliottii wood, in the horizontal plane sanding, by varying the particle size of the aluminum oxide (80, 100 and 120 mesh). The output variables evaluated were sanding force and wood roughness, along with those variables analyzed the surface integrity by scanning electron microscopy (SEM). For each experiment were performed 6 replications in a factorial arrangement in blocks. Sanding force data were obtained by a load cell, roughness using a Taylor Hobson Surtronic 25 + model and images of a scanning electron microscope Zeiss EVO LS-15. With this study we conclude that there is a decrease in the sanding force comparing the larger grain size (80 mesh) with others, but when compare the finest grits (100 and 120 mesh) there aren't a significant variation. The roughness decreases using thinner sandpapers. The SEM images can show some problems wood sanding, such as fragmentation of the fibers, embedding of abrasive grains on the surface and other materials impregnated into surface.*

Keywords: *Sanding, aluminum oxide, roughness, sanding force, SEM*

1. INTRODUCTION

Wood is a material with heterogeneous and high variability of characteristics among species. This heterogeneity is caused by several factors, such as soil, climate, harvesting age, among many others. With this we have different characteristics if we compare different parts removed along its length and diameter.

Being a material easy machinability compared to other materials such as metals and ceramics, so maybe there looking to improve manufacturing processes involving these species isn't as great compared to other types of materials. However, with the increasing expansion of the sector and the increased use of these species, it is important to study and understand the interactions and effects of the parameters involved in the process of sanding, correlating them with the quality of the final product. Knowledge of the sanding process and the variables that surround contribute to rational use of raw materials generating higher profits and contributing to the strengthening of the timber industry. It is worth mentioning that it is still insufficient number of researchers worldwide who are seeking to understand the process of sanding wood and the variables that surround it. This process, which has many variables that influence the quality of the manufactured component (SANTIAGO, 2011).

According Koch (1964), the grinding process can be divided in two working steps: thinning, where the processes are performed to prepare the timber, reducing more or less the surface roughness of the workpiece, and finishing, where the processes of preparing sanding wood for subsequent application of finishing materials.

To GONÇALVES *et al*. (2010) the mechanism of material sanding usually takes place in three steps:

- friction with abrasive grit and sanding material that generates surface modification in part to the eminence of the abrasive grain cutting the material;
- Deformation where material displacement occurs moment in which the material comes into elastic deformation and starts the formation of the chip;
- cutting, shearing process material that is characterized by the ability of the abrasive grain interact with the material of the workpiece chip formed by cutting.

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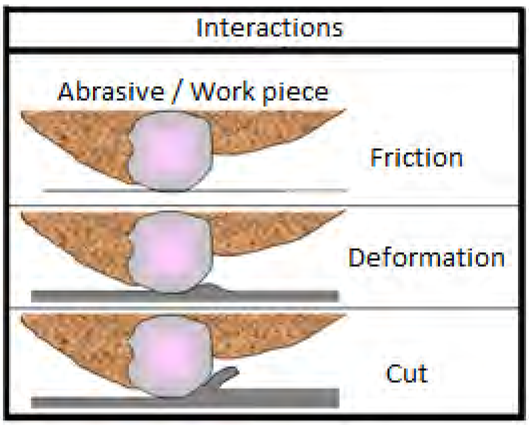

Figure 1 - Schematic representation of the interactions of the abrasive tool with the piece-work. (SUBRAMANIAN, K. apud GONÇALVES *et al*.)

According Saloni (2007) the sanding process involves changing the topography of the surface of the wood by the action of an abrasive material. The process of material removal by abrasive produces small particles (chips) that come from the removal of the wood fibers, where due to the variability of wood material faults can occur in this location, being of paramount importance to study the anatomical, physical and chemical wood for understanding the mechanism of sanding.

Ratnasingam & Scholz (2004) explain that there's an effect of the wood's anatomical characteristics on the sanding process as growth rings, wooden abnormal proportion of heartwood and sapwood wood, texture, etc. extractives., Which are features that should be considered. The proportion of growth rings and wood heartwood and sapwood varies with the cutting position on the tree, and their proportions IRAM influence the strength of sanding and outcome quality sanded surface.

The importance of choosing the correct abrasive is due to its hardness. Harder materials are usually more friable and thus suffer a greater breach of its abrasive grains. According Callister (2007), the aluminum oxide has a Knoop hardness of 2100 and 2800 silicon carbide.

2. MATERIALS AND METHODS

For the tests were made test samples of *Pinus elliottii* in the dimensions of 54x30x23mm (Figure 2).

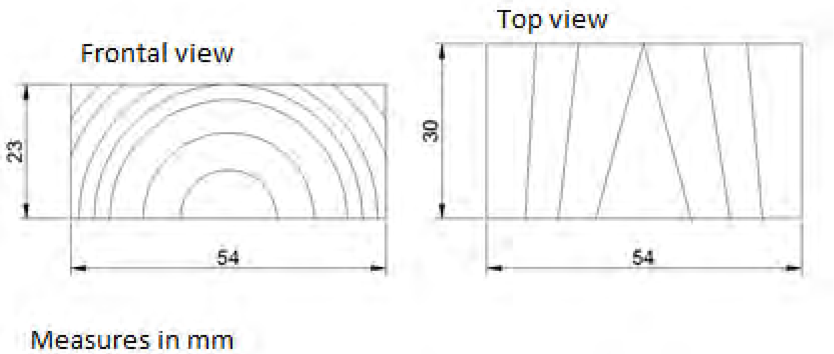

Figure 2 - Samples and dimensions

These samples had their moisture content stabilized at approximately 15% after stabilization, and were properly conditioned according to NBR 07190/1997 to "class moisture 1-12% EU" in a climate chamber brand TECNAL model TE 4001.

For the tests we used the sander flat BALDAN® brand, model LFH-2 fitted with a bracket for mounting the specimen (Figure 3) which was made of AISI 1010 which has a pneumatic cylinder for pressure variation during the test. This support is for side mounting the sander.

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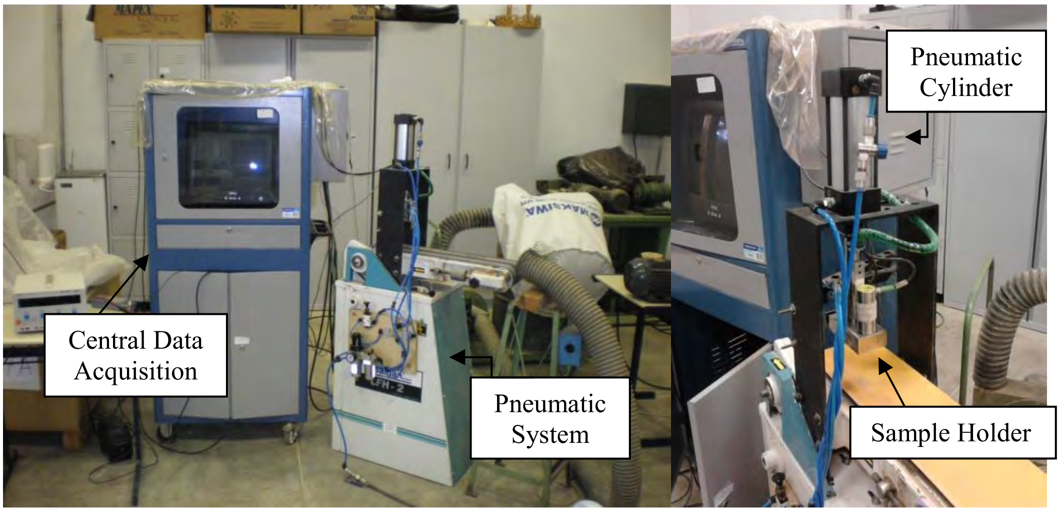

Figure 3 - Sander and acquisition central data

Tests were performed varying from 3 to aluminum oxide sandpaper (80, 100, and 120 mesh).

To capture the sanding force (force and power) used a load cell for collecting the force sanding marks Berman© load cells, TBSPL model with capacity of 250 N.

The load cell had to be calibrated to obtain their efforts to N. This calibration was performed using known masses and then drawn to a curve to find the calibration equation (Equation 1).

$$F = (25{,}812xUcc - 205{,}64)x9{,}8 \qquad \text{Eq. (1)}$$

Where:

F = Sanding force (N)

Ucc = Output DC voltage of the load cell proportional to the effort (V)

All data were acquisitioned with a National Instruments data plate, NI PCI 6220 model. The data acquisition board has the function of receiving the analog signals from the sensors and turn them into digital signals to be interpreted by the software in the PC. The software used to capture the data acquired by the sensors was developed in LabView ® 7.1 software from National Instruments, which has drawn up a program to acquire data with an acquisition rate of 400 points per second in matrix form.

To measure the surface roughness used a brand profilometer Taylor Hobson Surtronic 25 + model of measuring rod tip toucheable cone-spherical diamond tip radius of 2 mM (Figure 4). Picked up the Ra parameter for assessing the state of the sanded surface, and second Carpinetti et. al. (1996) because this parameter is not influenced by peaks and valleys stemmed from wood anatomy that can skew the results.

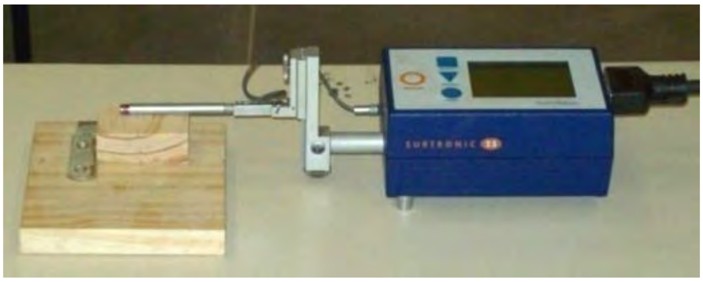

Figure 4 - TAYLOR HOBSON rugosimeter brand, model Surtronic 25 +.

The images of scanning electron microscopy were obtained through a microscope Zeiss EVO LS-15 mode variable pressure (VP) without metallization.

3. RESULTS AND DISCUTION

Once processed the data and made the statistics we obtained the following charts and tables.

3.1. Sanding force

Figure 5 shows the average values of sanding force.

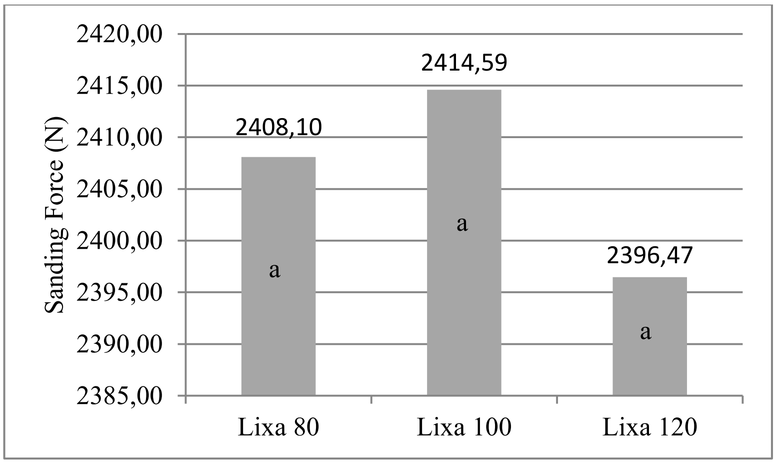

Figura 5 - Sanding force

Table 1 shows the Tukey test for the samples.

Table 1- Tukey's test for sanding force

Levels	Center	Lower Limit	Upper Limit	P-value
120 mesh - 100 mesh	-18,12	-76,03	39,78	0,70
80 mesh - 100 mesh	-6,49	-64,40	51,41	0,95
80 mesh - 120 mesh	11,63	-46,28	69,53	0,86

Despite the variation in strength values statistically these values do not differ, it must be because all three particle sizes are classified in the same class as average particle size, and are recommended for sanding wood pieces preliminary second Hawks (2005).

3.2. Roughness

Figure 6 shows the roughness values obtained with the sanding process.

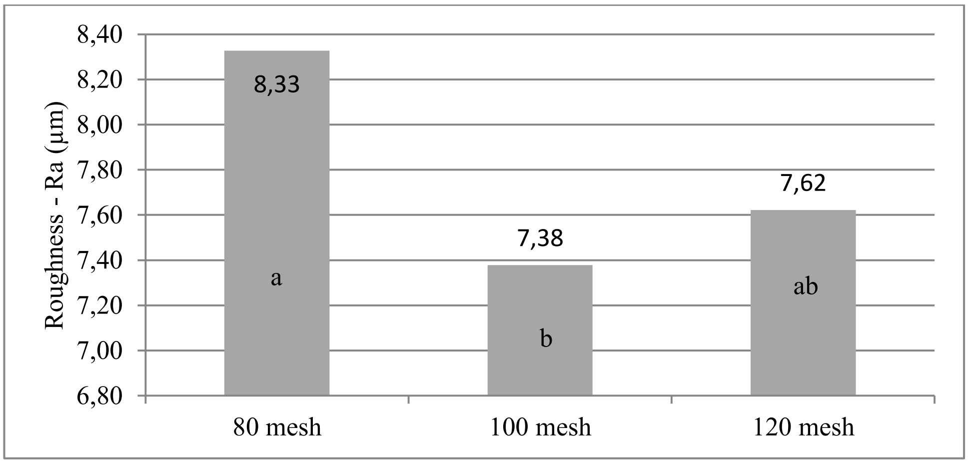

Figura 6 – Roughness Ra

Table 2 shows the comparison between roughness statistically.

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Table 2 - Tukey's test for roughness

Levels	Center	Lower Limit	Upper Limit	P-value
Lixa 120-Lixa 100	0,24	-0,63	1,12	0,75
Lixa 80-Lixa 100	0,95	0,08	1,82	0,03
Lixa 80-Lixa 120	0,71	-0,17	1,58	0,12

Looking the Table 2 and compared with the values in Figure 6 it is noted that the abrasives 80 and 120 are equivalent so as sandpaper 120 and 100. But sanding sheets 80 and 100 generate statistically different values. Sandpaper 100 still get the lowest roughness, and with 80 grit sandpaper get the larger value.

In the case of wood to be a heterogeneous material when we sand should take care to remove the larger surface imperfections because if you use sandpaper finer (smaller particle size) that may end up with only small imperfections in the case of sandpaper 80 mesh obtained a higher roughness because this grain have a bigger grain.

3.3 Scanning electron microscopy

Figure 7 shows the images obtained by scanning microscopy electronica with 2 types of extension (1000x and 2000x).

Figure 7 - Scanning electron microscopy of three particle sizes (a) 1000x and (b) 2000x.

By analyzing the SEM images we noticed that the images referents particle size of 100 mesh does not have deep flaws on the surface, but a lot of material compacted depressions where these exist. However when analyzing the images of particle size 80 to 120 mesh noted that, especially in the 80 mesh, there are deep valleys, which results in increased roughness value.

If we take into account the strength values sanding can see that the appearance of the grain sizes of 80 and 120 shows us the direction of sanding, concluding that in this case the sandpaper cut more than compacted surface material, but by analyzing the sandpaper grain size 100 is not so easy to identify this direction due to compaction of material in the sanded surface.

4. CONCLUSIONS

From this work we can conclude that:

- No statistically change was confirmed when comparing the sanding forces, yet the largest sanding force value was obtained at a particle size 100 mesh and the smaller value on 120 mesh.

- The lower roughness values were obtained with particle size of 100 mesh and 80 mesh with the largest. This is due to high compression of the material on the surface rather than the removal of this observer can in SEM.
- The SEM for wood works in identifying valleys and compacted material. The surface which had a higher amount of compacted material was sanded with a particle size of 100 mesh and the greatest number of valleys was 80 mesh.

5. ACKNOWLEDGEMENTS

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