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HYGROSCOPICITY OF CHIPBOARD VERSUS SOLID WOOD

Aurel LUNGULEASA
Faculty of Wood Engineering, Transylvania University, Brasov, Romania

Abstract: *The paper presents some aspects referring to water absorbtion and thickness swelling for solid wood and chipboard (with and without melamine film for protection). There is made a comparison between the two wooden materials in terms of hygroscopicity. A similar methodology was used in order to obtain all results in the same conditions. Also, it was taken into account that wood has a different swelling in tangential and radial direction and in the case of film covered chipboard the large swelling was near the cuts and very small to the center of the specimen. Results have showed that swelling of covered chipboard was lower than on solid wood.*

Keywords*: higroscopicity, chipboard, composite, solid wood, swelling*

1. INTRODUCTION

Hygroscopicity of solid wood and other wooden products as chipboard is an important property because in the range of saturation moisture content the dimensional changes (swelling and shrinkage) are produced. Beyond of certain limit of moisture content (fiber saturation point, FSP) and certain time the woody semi-product will be destroyed. When water mass that is absorbed in woody products will be reported to its initial mass the phenomenon can be name the water absorption and is specific for wooden panels as chipboard, fiberboard, plywood, laminated wood and so on. The same term is for solid wood [1, 2, 3]. Consequently, the water absorption, specific for both solid wood and boards, is calculated with the next relationship (Eq. 1):

$$A_w = \frac{m_i - m_f}{m_i} \cdot 100 \quad [\%] \tag{1}$$

Where there are: A_w –water absorption, in %; m_i - initial mass of wooden sample before immersion, in g; m_f – final mass of wooden sample after immersion in water, in g.

More important from the point of view of hygroscopicity is thickness swelling, for solid wood and wooden panels, even is a consequence of the first phenomenon, but only in the range of bound water from wood (up to FSP). This hygroscopical property has name the thickness swelling and is determined on the base of initial and final wooden dimensions, as follow (Eq. 2):

$$\alpha_t = \frac{t_f - t_i}{t_i} \cdot 100 \quad [\%], \tag{2}$$

Where there are:
β_t- thickness swelling, in %;
t_f is final thickness if woody sample, in mm;
t_i – initial thickness of woody sample, in mm.

The wooden boards as chipboards, fiberboards, laminated products and plywood present different properties of hygroscopicity related to solid wood, usually higher because of destroying of wooden integrity in particles or sheets. Behavior related to water of wooden materials could hardly be changed because of adhesive quantity and type. Therefore when there are used phenol-formaldehyde adhesive the hygroscopic properties will be improved, because these adhesives are themselves to water resistant and a part of these will penetrate superficial area of wooden products. In this way it can say that wooden boards with phenol-formaldehyde adhesive will be use in medium with great air humidity as plywood for constructions. Even mechanical strengths are higher but also the cost prices in this case are higher.

For chipboard the both properties of hygroscopicity depend also if their surfaces are covered or not with protection films. Therefore for comparison it must took samples with protection film and others without protection films. The samples for solid wood used for comparison will have different values of higroscopicity on radial and tangential directions, reason for what it should determine the both properties on radial and tangential directions and after that, it made the average of these values.

Also, because the wooden specie influences very much the hygroscopical properties of boards in the work-paper it should use only beech specie both for solid wood and for wooden panels (chipboard with and without film coating).

The main objective of this paper is to find out how water or high humidity affects the swelling and water absorbtion properties of solid wood (in the tangential and radial direction) and non-covered or melamine–covered chipboard (in thickness), in order to use them corespondingly.

2. METHODIC AND MATERIALS

Before of actually experiments all wooden samples were conditioned into atmosphere with constant parameters up to all samples reached a constant moisture constant about 10 %. Form of all wooden samples were prismatic, the samples from solid wood having dimension 100×20×20 mm and the samples from chipboard having 50×50×18 mm (Fig 1). These different dimenssion are adopted for obtaining a similar outside surfaces for both categories of the sample types, namely about 86 - 88 cm^2, the delection from both type of samples being only 2,3 % [4], respectively in resonable limits.

Wooden samples were introduced grouped (5 pieces) into water down to about 2 cm under superior level of liquid, for a time of 2 hours and a constant temperature 18 ^{0}C [5, 6]. Before immersion of wooden samples it should make the next determinations:

- For wooden panel (chipboard with and without coated films), there are determined the initial mass with 0.1 g accuracy and initial thickness of all samples with 0.01 mm acuracy;

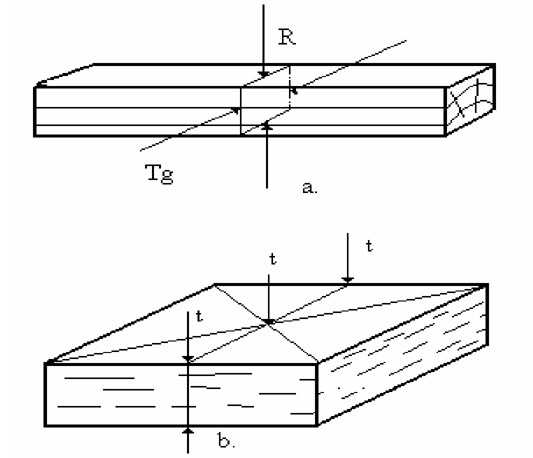

Fig 1. Form and dimensions of woody samples: a-for solid wood; b-for chipboards; R-radial; Tg-tangential; t-thickness of panel boards

- For all solid wood samples there are determined the initial mass, with the same accuracy 0.1 g;
- For all solid wood samples the dimensions on radial and tangential directions are determined with an accuracy of 0.01 mm;
- For water it must carry out and keeping the temperature to regime one (temperature 18 ^{0}C, PH neutral, cleaness and without carbonates etc).

The same determinations referring to wooden samples were make after testing, namely in the moment of sample evacuation from water. Also it keep into account the water adsorbent to sample surfaces that might to eliminate by low pressing with absorbent paper. Time of weighing and measuring must be very short because water can be rapidly evaporated. For covered panels with decorative and protection films it keeps into account that the thickness of wooden samples after immersion will be better in outside zone and the lowest in the middle zone of sample, determining both values of thicknesses. Therefore if the solid wood is use two specific relationships are necessary.

$$\alpha_{tt} = \frac{t_{ft} - t_{it}}{t_{it}} \cdot 100 \quad [\%]$$
$$\alpha_{tr} = \frac{t_{fr} - t_{ir}}{t_{ir}} \cdot 100 \quad [\%] \tag{3}$$

Table 1
Hygroscopical results for solid wood

N	Mass, g		Thickness, mm		α_{tr}	α_{tt}	A_w, %	α, %
	m_i	m_f	r_i/r_f	t_i/t_f				
1	32,6	33,3	19,7 20,0	20,4 20,9	1.5	2.4	2.4	1.95
2	32,4	32,9	19,8 20,1	20,4 20,9	1.5	2.4	4.6	1.95
3	32,8	32,9	19,9 20,1	20,4 20,9	1.0	2.3	3.3	1.65
4	31,6	32,3	19,8 20,1	20,4 20,9	1.5	2.3	2.2	1.94
5	30,2	30,9	19,7 19,9	20,9 21.8	1.0	2.4	2.3	1.70
Mean							2.5	1.83

Where there are: α_{tt} is swelling coefficient of solid wood on tangential direction, in %; α_{tr} is swelling coefficient of solid wood on radial direction, in %; t_{fr}, t_{ft} – final thickness of solid wood on radial and tangential direction after imersion, in mm; t_{ir}, t_{it} – initial thickness of solid wood on radial and tangential direction before imersion, in mm;

Keeping into consideration that chipboard has not radial and tangential direction, in order to make a good comparision between solid wood and chipboard there was take a medium value of radial and tangential values, namely:

$$\alpha_t = \frac{\alpha_{tr} + \alpha_{tt}}{2} \tag{4}$$

Results of hygroscopical tests was centralized in a lot of tables separated for each type of sample (solid wood and chipboard).

3. RESULTS AND DISCUSSION

On the base of measurements that are made for each type of wooden products it may realize a lot of tables, from what it can extract water absorption and thickness swelling as an medium value for entire testing, as it sees for instance in the Table 1 for uncovered chipboard or in the Table 2 for solid wood.

Table 2
Hygroscopical results for composites

No	Mass, g		Thickness, mm		A_w, %	α_t, %
	m_i	m_f	t_i	t_f		
1	32.2	62.2	17.3	22.2	93.1	28.3
2	32.3	62.0	17.2	22.4	91.9	30.2
3	32.3	62.8	17.4	22.4	94.4	28.7
4	32.4	63.0	17.4	22.2	94.4	27.5
5	34.1	64.3	17.2	21.8	88.5	26.7
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For solid wood there is a radial and tangential swelling, reason for what for obtaining the thickness swelling it may do the average of above values from Table 2.

Because there were made a lot of tests for each type of wooden products after finishing of tests it takes data from many tests and put together in the centralized Table 3, for obtaining the main tendency parameter as arithmetic average of these.

Table 3.
Hygroscopicity for different wooden materials

No.	Assortments	A_w, %	α_t %
1	Solid wood	2.5	1.8
2	Melamine chipboard	9.1	(1.0+3.7)/2=2.3
3	Chipboard	92.4	28.2

On the base of these value it may do two graphs for visualizing the tendency of wooden products, as it sees in Fig 2 for water absorption and Fig 3 for thickness swelling.

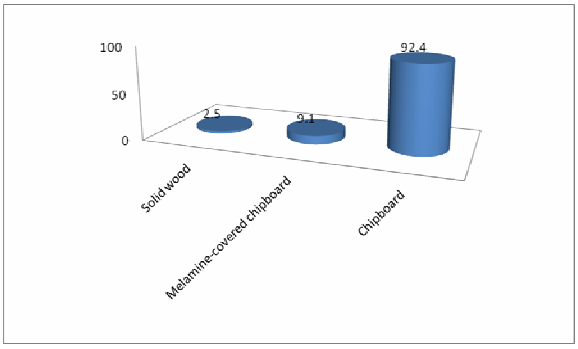

Fig 2. Water absorption for woody materials

It can observe from Table 3 that the best lower water absorption are for solid wood (with 2.5%), the next being melamine-covered chipboard (with 9.1%) and the lowest water absorption is for non-covered chipboard, with 92.4 %.

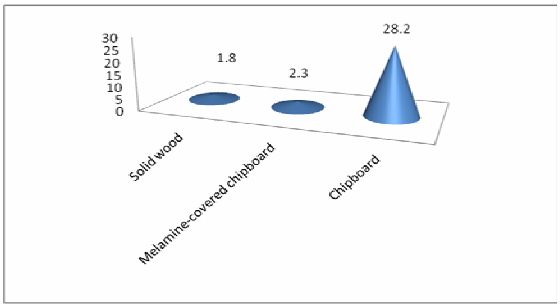

Fig 3. Swelling of woody materials

The same considerations are exposed in Fig 3 related to thickness swelling for different types of wooden materials. As general rule, the classification is the same as for the water absorption, namely: on the first place is solid wood with 1.8 %, on the second place is melamine-covered chipboard with 2.3% on average and last position remains to non-covered chipboard with 28.2 %.

Refering to thickness swelling of melamine-covered chipboard it has two different values, namely in the middle of sample with 1.0% (obtaining the first place, before the solid wood that has 1.8%) and the thickness swelling on the edge with 3.7% (placing the melamine-covered chipboard on the second place). Therefore it can conclude that in terms of thickness swelling, the melamine-coated chipboards are superior even than solid wood.

Additionally, in the paper, several measurements were made on water absorption and thickness swelling of wood-plastic composite. The results (water absorption of 0.3% and 0.2% thickness swelling) showed that this compound is different from the other two materials taken into consideration in the paper. There are no terms of comparison between these types of materials related higroscopicity.

4. CONCLUSION

Study about hygroscopicity of wooden products as agglomerate wooden products versus solid wood was a constant problems of researches from all countries all over of world for finding certain methods for improving this property, the last frontier being the obtaining of wooden products without higroscopicity. Nearby of these two materials the wooden material from plastics and wood fiber is taken in consideration for what hygroscopical properties are very low, about inexistent.

From experimental studies it can observe that the melamine-covered wooden panels have a low higroscopicity related to un-covered boards and even related to solid wood. From this point of view a good covered board is better than solid wood as timber could be, beside other currently features of these boards as low cost, broad dimensions, uniform thickness and plainly.

All studies made in the paper about higroscopy of woody materials have the aim of water absorption and thickness swelling, in order to use them corespondingly.

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