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LONG-TERM EFFECT OF TEMPERATURE ON THE PROPERTIES OF OSB/4*

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Abstract. Studies were made on the effect of the temperature in the conditioning chamber and the time of its action on the properties of OSB/4 glued in the inner layer with PMDI resin. The testing results showed that boards used for the purpose of the study were characterized by very good strength properties, and their values considerably exceed the requirements of the standard specification. Both the long-term action of air with increased (+60°C) and lowered (–20°C) temperature resulted in a decrease in their properties. Nevertheless, even after 12 weeks seasoning the studied boards complied with the requirements of the EN 300 standard.

Key words: OSB/4, weather resistance, strength

INTRODUCTION

The OSB is a modern constructional and finishing material, which, first of all, is commonly used in the USA, Canada and recently in Germany, especially in the construction of buildings in the framework technology. It shows appropriate technical strength parameters, which guarantee the rigidity and strength of the building structure. Also in Poland, in 1997, the manufacturing of OSB started in the production line with the effectiveness of over 300 000 m^3/year. The OSB board is characterized by the stability of shape, a very good resistance to atmospheric conditions and impacts, as well as a good sound isolation, easy workability and processability. Due to its properties the OSB board is an alternative solution for the building and furnishing industry, because it can successfully replace plywood and timber, used so far, while being considerably cheaper.

The requirements in relation to physical and mechanical properties of OSB boards are defined by appropriate specifications. However, the requirements respecting their resistance to the long-term action of the changeable environmental conditions have not

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been specified. It is very important in case of their use for building engineering as the elements working in the interior applications, for example: as roofing, outer walls, ceilings and structure elements of girders, I-beams and trusses. The studies made so far concerned mainly boards glued with phenolic resin with the use of different wood species particles [Pu et al. 1992 a, b]. Moreover, the boards were subjected to the action of air with changeable humidity while maintaining constant temperature [Mohammad and Smith 1996, Wu and Suchsland 1996, 1997]. The studies also referred to the adequacy of accelerated aging tests of the boards to determine their properties in the long-term use conditions [Okkenen and River 1996]. None of these works regarded OSB made of pine particles glued in the inner layer with PMDI, and in the outer layer with MUPF resin. In the earlier studies conducted at the Department of Wood-Based Materials, the August Cieszkowski Agricultural University of Poznań [Derkowski et al. 2002, 2003, Czarnecki et al. 2003] the long-term action of air with both increased and changeable humidity was investigated in terms of its effect on the properties of thus glued OSB/3 and OSB/4 boards. There have, however, been few reports directed towards the properties of OSB boards depending on changeable environmental temperature. It is known that the OSB boards used in the residential building engineering are at risk of the action of the changeable temperature in a very wide range. Merely, the studies were made of the short-term action of the air with increased temperature (from +20 till +140°C) on the modulus of rupture of particleboards, MDF and OSB boards [Bekhta et al. 2003]. The results from these experiments showed that the OSB boards turned out to be the most resistant to the short-term action of increased temperature. Thus, the purpose of the present study is to investigate the effect of the long-term action of the air with different temperatures on the properties of OSB/4 boards, i.e. boards with increased capability of load transfer for use under humid conditions.

MATERIALS AND METHODS

OSB/4 boards produced under industrial conditions with the thickness of 15 mm glued in the inner layer with PMDI resin and in the outer layer with MUPF resin were used in the study.

In order to determine the effect of the temperature of the environment on their properties, the boards were subjected to the action of the temperatures at –20, +40 and +60°C for 12 weeks. The measurements of the board properties were made after 4, 8 and 12 weeks and were taken immediately after the samples were removed from the conditioning chamber and after repeated air-conditioning under standard conditions.

The properties of the particleboards were examined according to the relevant European Standards (EN):

– modulus of rupture (MOR) and modulus of elasticity (MOE) according to EN 310,
– internal bond (IB) according to EN 319,
– moisture resistance after a boil test according to EN 1087-1: 1995,
– swelling in thickness after 24 hours according to EN 317.

In case of the swelling in thickness, IB, moisture resistance, MOR and MOE evaluations 12 samples per each board were tested in order to evaluate the mean value and standard deviation.

THE DISCUSSION OF RESULTS

The results of the studies on the effect of the action of the air with the temperatures of –20, +40 and +60°C and the time of its action on the properties of OSB/4 boards are presented in Tables 1 and 2. The data included in Table 1 show that the investigated boards were characterized by very high values of the modulus of rupture both along the larger and smaller axis, considerably exceeding the requirements of the EN 300 standard. What is more, as the time of the action of the temperature at –20°C was extended

Table 1. The effect of the temperature and time of its action on the modulus of rupture and modulus of elasticity of OSB/4
Tabela 1. Wpływ powietrza o różnych temperaturach oraz czasu jego oddziaływania na wytrzymałość na zginanie i moduł sprężystości płyt OSB/4

The conditions of air-conditioning Warunki klimatyzacji	Measurement after, weeks Pomiar po upływie, tygodnie	Modulus of rupture, MPa Wytrzymałość na zginanie, MPa				Modulus of elasticity, MPa Moduł sprężystości, MPa			
		non-conditioned nie klimatyzowane		after air-conditioning po klimatyzacji		non-conditioned nie klimatyzowane		after air-conditioning po klimatyzacji	
		larger axis oś większa	smaller axis oś mniejsza	larger axis oś większa	smaller axis oś mniejsza	larger axis oś większa	smaller axis oś mniejsza	larger axis oś większa	smaller axis oś mniejsza
Value according to PN/EN-300 Wartość wg PN/EN-300	–	26.0	14.0	26.0	14.0	4 800	1 900	4 800	1 900
Control board Płyta kontrolna	0	37	26	37	26	6 460	3 480	6 460	3 480
Standard deviation Odchylenie standardowe		1.2	0.8	1.2	0.8	250	160	250	160
–20°C	4	41.0	29.0	43.7	20.0	6 430	3 670	6 130	3 140
12 weeks		2.1	1.1	2.3	1.1	240	200	260	260
12 tygodni	8	42.5	30.5	28.2	18.9	6 670	3 910	4 920	3 110
		1.8	0.9	2.0	1.5	360	240	210	240
	12	44.8	31.5	24.9	15.0	6 820	4 180	3 720	2 130
		1.9	1.5	1.8	1.5	310	210	230	190
+40°C	4	36.4	25.0	36.2	22.9	6 350	3 370	5 890	3 270
12 weeks		1.5	1.3	1.3	1.6	310	210	300	210
12 tygodni	8	35.1	23.5	29.4	18.1	6 040	3 250	5 090	2 870
		1.6	1.8	1.7	1.3	320	190	310	190
	12	33.8	22.3	29.1	15.9	5 960	3 280	4 270	2 300
		1.9	1.3	2.0	1.4	290	230	210	150
+60°C	4	33.5	23.0	34.2	23.0	6 060	3 280	5 090	3 270
12 weeks		2.1	1.8	2.0	1.9	320	200	210	190
12 tygodni	8	30.3	21.0	29.5	17.2	5 650	3 040	4 940	2 930
		1.5	0.9	1.5	1.1	360	170	260	260
	12	28.1	19.2	26.6	14.6	5 430	2 730	3 570	2 190
		2.1	1.8	1.8	1.3	340	140	200	210

Table 2. The effect of the temperature and time of its action on the internal bond, moisture resistance and swelling in thickness of OSB/4
Tabela 2. Wpływ powietrza o różnych temperaturach oraz czasu jego oddziaływania na wytrzymałość na rozciąganie prostopadłe do płaszczyzn, wodoodporność oraz spęcznienie płyt OSB/4

The conditions of air-conditioning Warunki klimatyzacji	Measurement after, weeks Pomiar po upływie, tygodnie	Tensile strength perpendicular to the plane of the board, MPa Wytrzymałość na rozciąganie prostopadłe, MPa		Swelling in thickness, % Odkształcenie grubości płyty, %
		after air-conditioning (internal bond), 20°C, 65% RH po klimatyzacji, 20°C, 65% RH	after a boil test (moisture resistance) po próbie gotowania	
Value according to PN/EN – 300 Wartość wg PN/EN – 300	–	0.40	0.13	–
Control board Płyta kontrolna	0	0.9	0.25	8.22
Standard deviation Odchylenie standardowe		0.13	0.02	0.7
–20°C	4	0.88	0.21	7.3
12 weeks		0.07	0.01	0.8
12 tygodni	8	0.76	0.18	6.7
		0.05	0.03	0.8
	12	0.75	0.17	6.4
		0.06	0.02	0.3
+40°C	4	0.85	0.23	7.9
12 weeks		0.04	0.02	0.8
12 tygodni	8	0.78	0.19	6.4
		0.09	0.02	0.4
	12	0.70	0.19	5.6
		0.05	0.04	0.7
+60°C	4	0.84	0.19	6.1
12 weeks		0.07	0.02	0.3
12 tygodni	8	0.81	0.16	5.7
		0.10	0.02	0.4
	12	0.81	0.15	5.3
		0.07	0.01	0.4

further improvement of these properties was observed, but only in case of boards the properties of which were determined immediately after they had been taken out of the conditioning chamber. As the temperature (from +40 till +60°C) and the time of seasoning (up to 12 weeks) increased, the MOR values decreased; both for boards the properties of which were determined immediately after they had been taken out of the conditioning chamber and for those which, before measurement, were kept under standard conditions. However, the former were characterized by better properties. Nevertheless, even after 12-week seasoning they complied with the requirements of the standard. A similar tendency was observed in case of MOE. This observation may indicate the

chemical processes occurring in the boards under the influence of the air with increased temperature. The significant decrease in their MOR and MOE (by 28 and 44% along the larger and smaller axis, respectively) may be due to the failure of the chemical bonds, either within the resin or in the wood-polymer phase boundary [Bekhta et al. 2003].

The research results proved that internal bond (Table 2) decreased as the temperature and time of its action increased, yet did not exceed 20% after 12 weeks. The same tendency was observed in case of the values of the IB after a boil test (Table 2). Although the greatest decrease of this property, by almost 40%, was obtained for the boards seasoned at +60°C for 12 weeks, they still met requirements of the EN 300 standard in terms of internal bond after the boil test.

As expected, the thickness swelling after 24 hours of soaking in water was very low (Table 2), due to the type of the used resins (MUPF and PMDI). However, no significant effect of the temperature and the time of its action was found on the swelling in thickness. On the other hand, the hydrophobic properties of the boards slightly improved as the temperature of the seasoning increased, however taking into consideration the values of the standard deviations it is negligible.

CONCLUSIONS

The results of the study proved that the investigated OSB/4 boards were characterized by very good strength properties. The long-term action of air with the temperatures at –20, +40 and +60°C resulted in a deterioration in their properties. Nevertheless, even after 12-week seasoning the studied boards complied with the requirements of the EN 300 standard.

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WPŁYW TEMPERATURY SEZONOWANIA NA KSZTAŁTOWANIE SIĘ WŁAŚCIWOŚCI PŁYT OSB/4

Streszczenie. Zbadano wpływ temperatury otoczenia oraz czasu jej oddziaływania na właściwości płyt OSB/4, zaklejanych w warstwie wewnętrznej żywicą PMDI. Badania wykazały, iż użyte do badań płyty charakteryzowały się fizycznymi i mechanicznymi właściwościami znacznie przekraczającymi wymagania normy przedmiotowej. Długotrwałe oddziaływanie na płyty powietrza o temperaturach –20, +40 i +60°C powoduje co prawda spadek ich właściwości wytrzymałościowych, jednak nawet po 12 tygodniach sezonowania w badanym zakresie temperatur spełniają one wymagania określone normą.

Słowa kluczowe: OSB/4, odporność na starzenie, wytrzymałość

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