

SELF-BINDING FIBREBOARD MADE OF STEAM EXPLODED WOOD: THE CASE OF MEDIUM DENSITY

Ramunas Tupciauskas^{1,2}, Andris Veveris² & Janis Gravitis²

¹Department of Wood Processing, Latvia University of Agriculture

*²Laboratory of Biomass Eco-efficient Conversion at
Latvian State Institute of Wood Chemistry*

Aim of the study

To obtain self-binding medium density board from locally grown alder wood (*alnus incana* (L.) Moench) pre-treated in steam explosion (SE) process and hot pressed under various conditions and testing of board properties to find dependence of the properties on manufacturing conditions and to compare the properties with the requirements of commercial MDF standards.

Samples pre-treatment and pressing conditions

Sample Nr.	Chips size for SEP, mm	SEP time, min / logR ₀ values	Mass pre-treatment after SEP	Water content before pressing, %	Pressing conditions			
					T, C	p _{max} /p _{min} , MPa	τ _{pr+cool} , min	h, mm
1	0.4 – 2	0.5/3.67	-	8.4	160	0.6/0.05	8+10	8
2	0.4 – 2	1/3.97	-	7.3	150	0.8/0.08	8+15	8
3	0.4 – 2	1/3.97	-	8.6	160	1.5/0.02	8+12	8
4	0.4 – 2	1/3.97	-	9.1	170	2.1/0.02	6+10	8
5	0.4 – 2	2/4.28	-	6.3	160	0.6/0.05	8+10	8
6	0.4 – 2	3/4.45	-	7.4	160	0.4/0.06	8+10	8
7	~ 20	1/3.97	crushed	8.2	170	0.5/0.02	6+10	8
8	~ 20	1/3.97	crushed	8.2	170	0.5/0.01	6+10	6
9	~ 20	1/3.97	W+crushed	15.3	170	0.8/0.01	6+10	6
10	0.4 – 2	1/3.97	crushed	12.7	170	0.6/0.01	6+10	6
11	≤ 2	1/3.97	-	19.2	170	0.3/0.01	6+10	6

Material and methods: manufacture of the board



Grey alder woodchips (~ 20 mm)



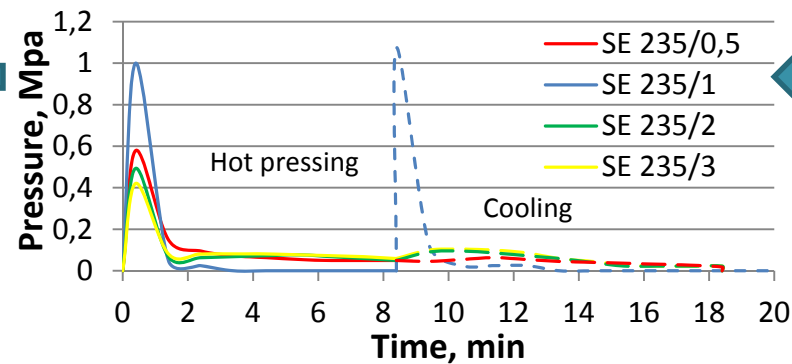
Milled chippings (sieve 2 mm)



T=235 C, t=0.5-1-2-3 min



Self-binding fibreboard specimens



T=150–170 C, p=0.01–2.1 Mpa, t=16–23 min

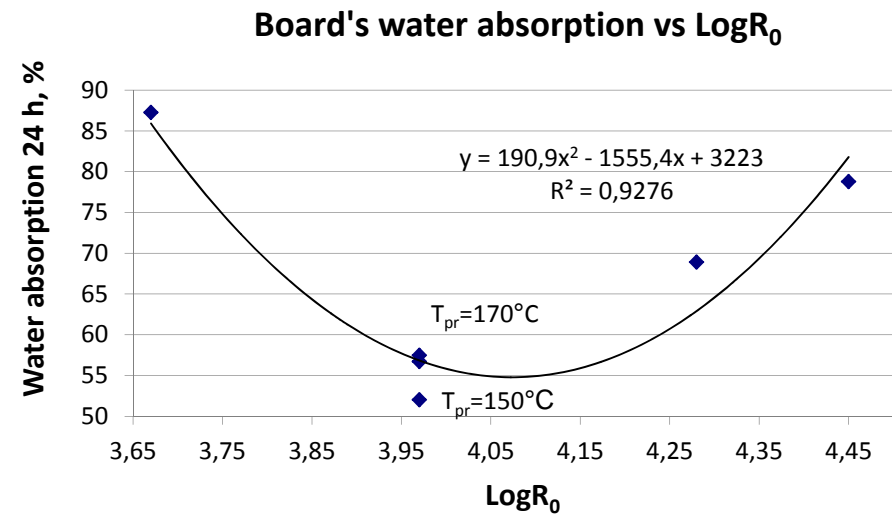
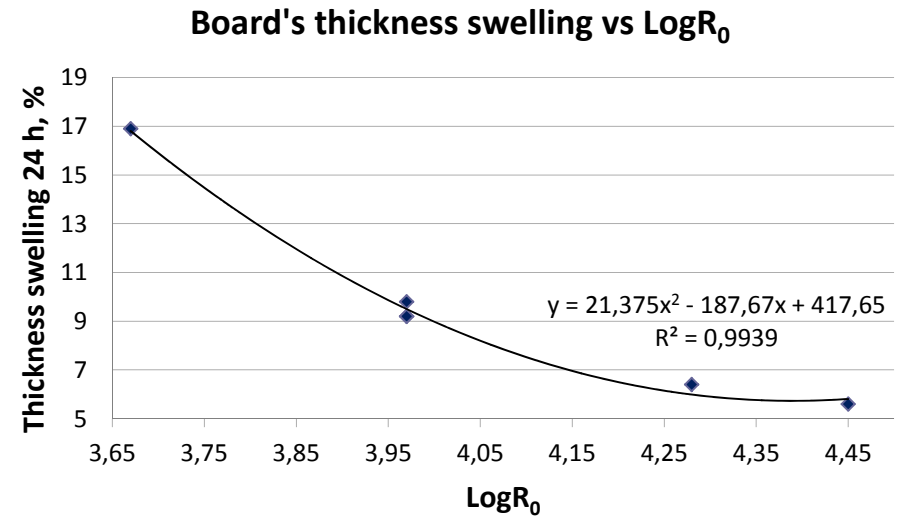
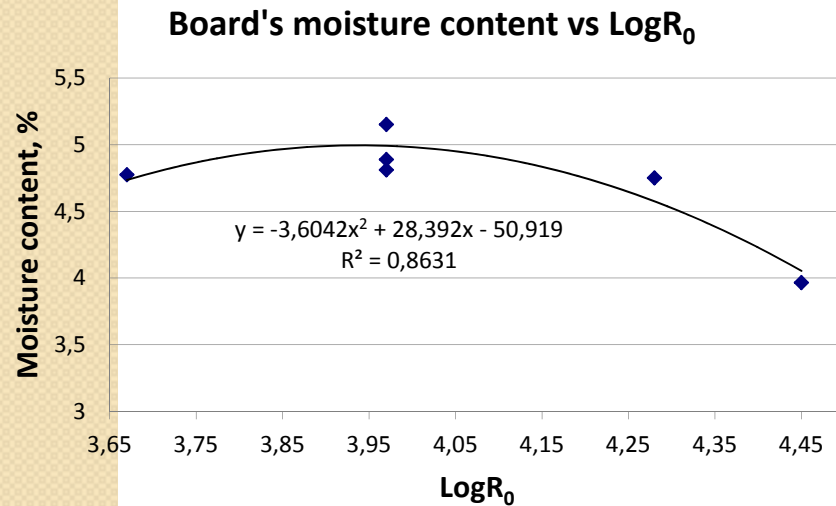
Material and Methods: testing the board properties

- Conditioning at $T=21 \pm 2$ °C and $H=65 \pm 5$ %
- Density (EN 323)
- Moisture content (EN 322)
- Thickness swelling and water absorption (EN 317)
- Bending strength and modulus of elasticity (EN 310)
- Internal bond (EN 319)

Results

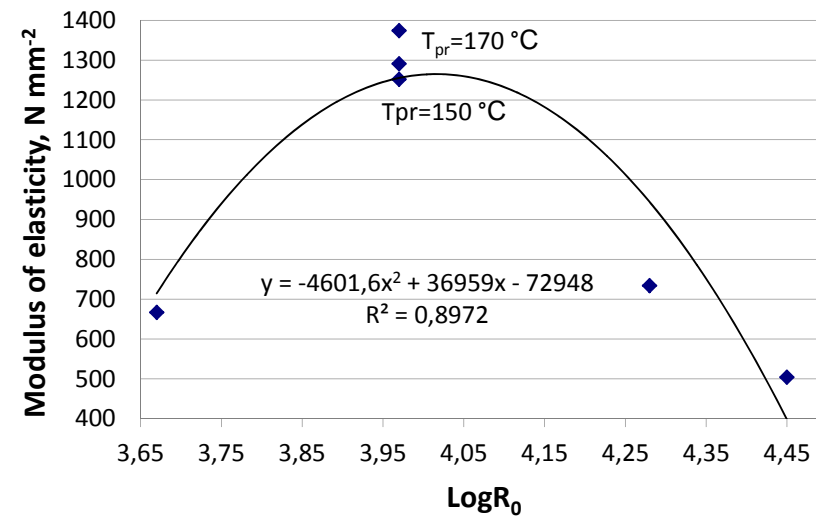
Nr.	t, mm	ρ , g cm ⁻³	MC, %	TS, %	WA, %	MOR, N mm ⁻²	MOE, N mm ⁻²	IB, N mm ⁻²
1	7.4 0.03	0.63 0.03	4.8 1.12	17 4.4	87 9	2.2 0.6	667 157	0.12 0.03
2	6.2 0.07	0.82 0.1	5.2 0.14	10 0.4	52 12	4.5 1.2	1252 247	0.27 0.02
3	6.2 0.04	0.78 0.05	4.9 0.46	9 0.5	57 7	4.4 0.9	1291 351	0.28 0.07
4	6.6 0.04	0.76 0.04	4.8 0.25	9 0.3	57 5	4.9 1.2	1374 362	0.26 0.04
5	6.8 0.04	0.69 0.06	4.7 1.29	6 0.8	69 9	2.3 0.7	734 225	0.30 0.07
6	7.4 0.03	0.64 0.06	4.0 0.9	6 0.9	75 8	1.3 0.4	504 151	0.19 0.05
7	9.3 0.17	0.48 0.02	6.3 0.08	7 0.5	143 11	0.5 0.08	76 38	0.03 0.02
8	6.1 0.19	0.68 0.02	6.0 0.1	10 1.3	78 8	1.9 0.2	434 87	0.17 0.01
9	6.8 0.21	0.65 0.03	5.1 0.07	19 1.5	107 10	3.6 0.7	547 103	0.07 0.03
10	5.9 0.18	0.72 0.02	5.4 0.07	8 1	64 5	5.4 0.8	1147 99	0.25 0.04
11	5.3 0.15	0.74 0.03	5.8 0.08	7 0.8	58 8	3.9 0.9	960 225	0.29 0.05
Stand EN622-5	> 6 - 9	0.4–0.9	11	17	–	23	2700	0.65

Results: physical properties vs SE conditions

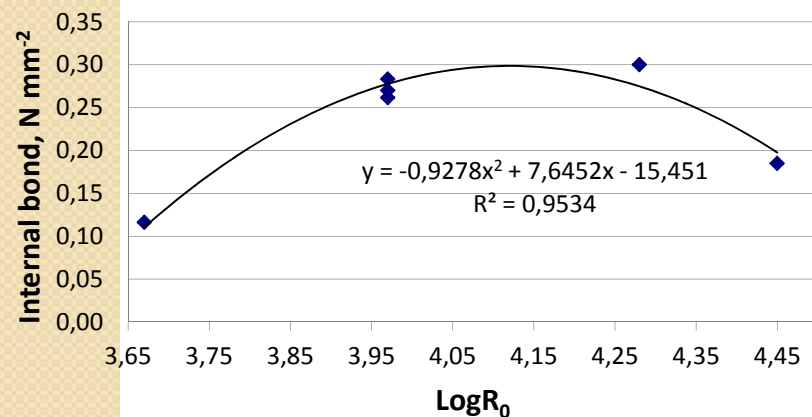


Results: mechanical properties vs SE conditions

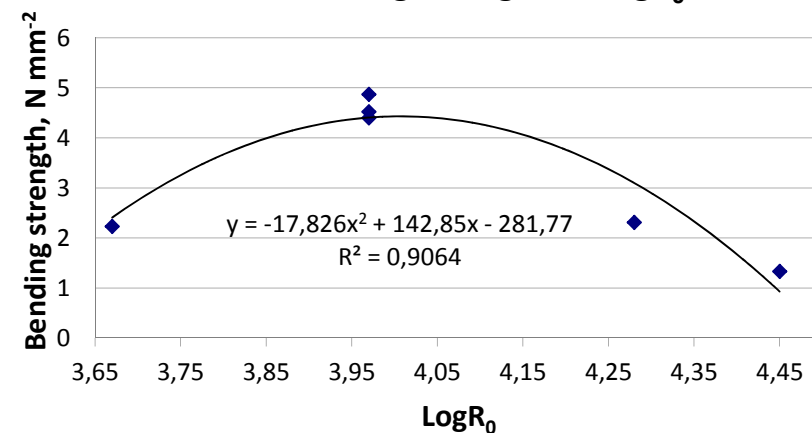
Board's modulus of elasticity vs $\text{Log}R_0$



Board's internal bond vs $\text{Log}R_0$

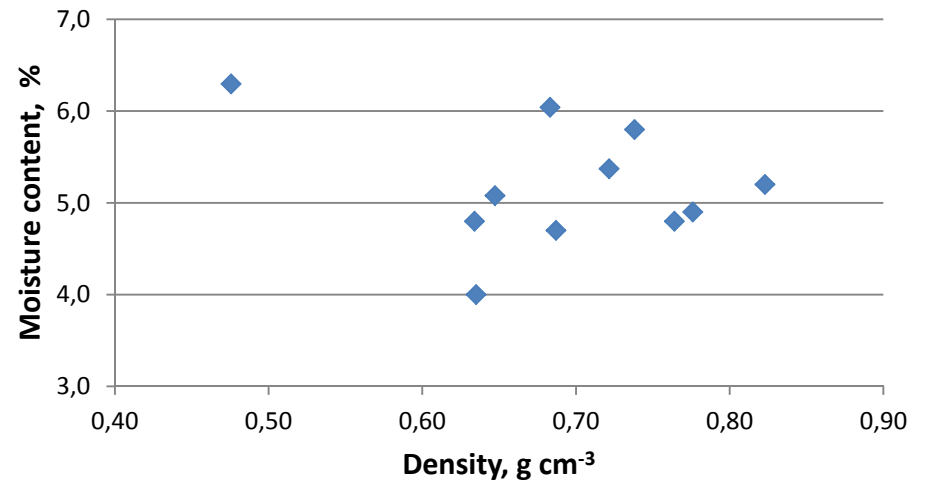


Board's bending strength vs $\text{Log}R_0$

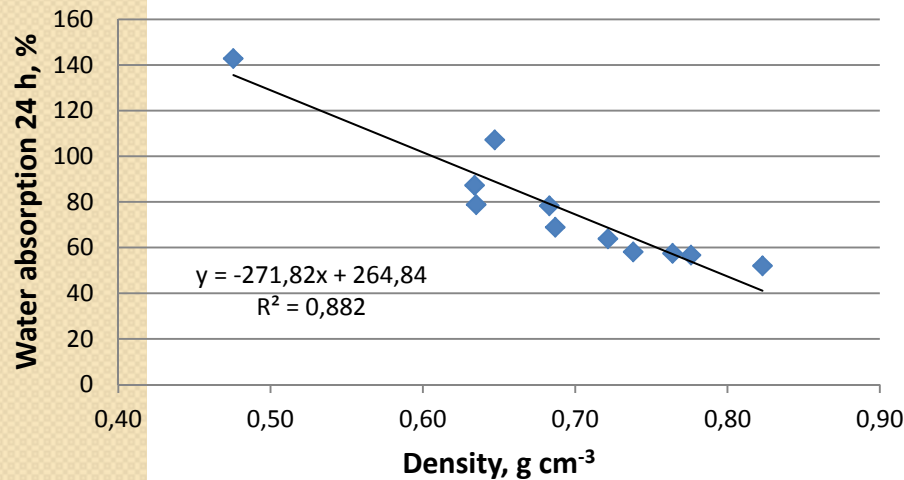


Results: physical properties vs density

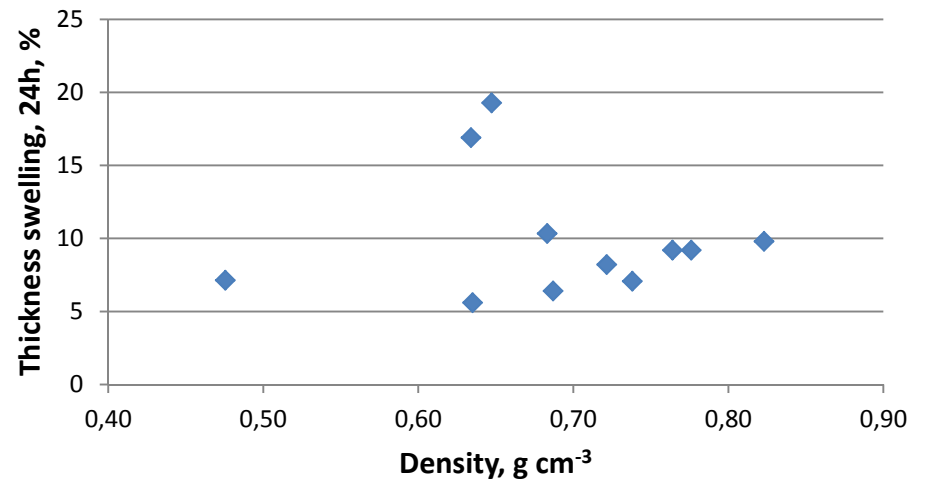
Board's moisture content vs density



Board's water absorption vs density

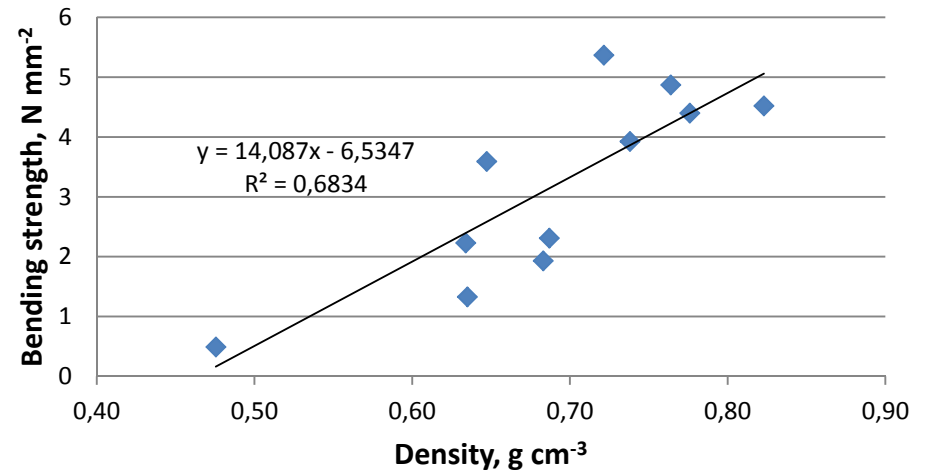


Board's thickness swelling vs density

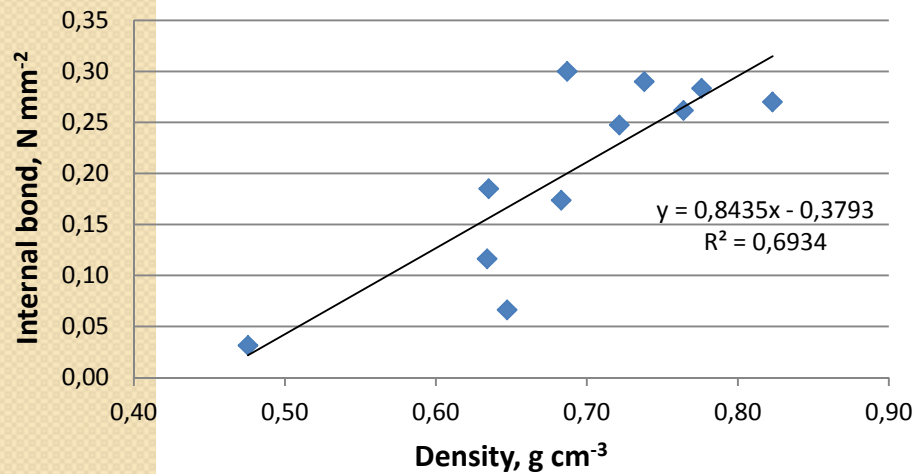


Results: mechanical properties vs density

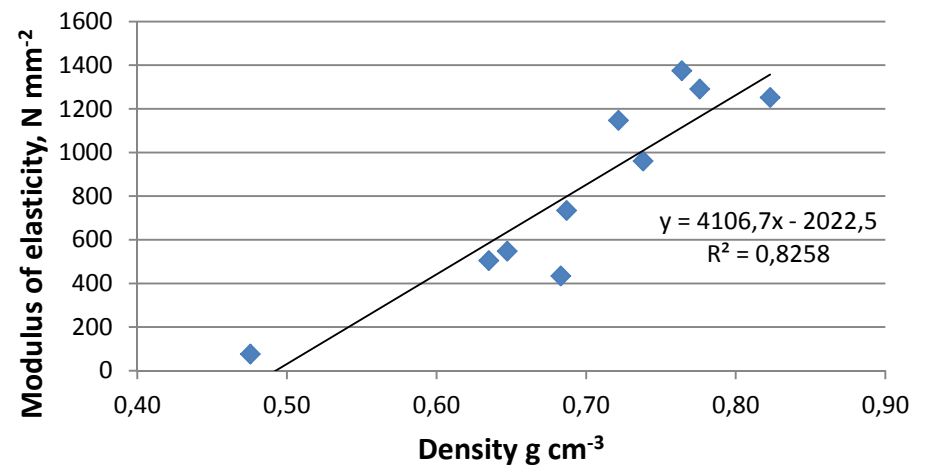
Board's bending strength vs density



Board's internal bond vs density



Board's modulus of elasticity vs density



Conclusions

- The obtained self-binding medium density ($0.5 - 0.8 \text{ g cm}^{-3}$) fibreboards from steam exploded grey alder chips show sufficient form stability (thickness swelling and water absorption) but poor mechanical properties (bending and internal bond) compared with requirements of EN 622-5 type MDF.
- Except of moisture content and thickness swelling, all other tested board properties correlate and improve with increasing the density.
- Homogenizing the exploded fibres by crushing did not show significant effects on the tested board properties.
- Increase of water content of the pressing mass significantly decreases thickness swelling and the modulus of elasticity while other properties show insignificant differences.
- Washing out the exploded fibrous mass with water increases a bit the modulus of rupture at bending but decrease the form stability and internal bond.
- The optimal producing conditions of the boards are found to be at severity of SEP at $\log R_0 = 3.97$ and pressing temperature of $170 \text{ }^\circ\text{C}$. The pressure and pressing time do not show significant effect on the tested properties of the boards.

Acknowledgements

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Thank You for Your attention!



7th meeting of the Nordic-Baltic Network in
Wood Material Science and Engineering
Oslo, Norway, October 27 – 28, 2011



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