Effect of Using Rock Wool on Mechanical and Physical Properties of Oriented Strandboard (OSB)

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Abstract: In this study, the effect of using different ratios of rock wool on the mechanical and physical properties of OSB (Oriented strandboard) boards, according to the place of use and properties of OSB. For this purpose, 18 mm x1220 mm x2440 mm (control, A1, A2, A3) at a density of 600 kg/m³ using rock wool in three different (10-20-30%) ratios, in proportion to the weight of the middle layer of the chipboard obtained from 100% maritime pine (*Pinus maritima*) wood. OSB/2 test boards were produced. OSB/2 test boards obtained as a result of using different proportions of rock wool were tested according to the relevant standards. According to the test results, when the mechanical and physical properties (tensile strength in the vertical direction, bending resistance, modulus of elasticity, swelling properties and free formaldehyde values) are compared with the control board, it has been determined that 10-20% rock wool can be used in the production of OSB/2 boards to be used as insulation board. Accordingly, rock wool reinforced composite OSB boards can be preferred as insulation boards in the wood panel industry.

KEYWORDS: *ORIENTED STRANDBOARD, ROCK WOOL, MECHANICAL AND PHYSICAL PROPERTIES.*

1. Introduction

The oriented strand board (OSB) market size was estimated at over 31 million cubic meters in 2021, and the market is projected to register a CAGR (The compound annual growth rate of more than 4% during the forecast period (2022-2027) [1]. Roughly 95% of OSB produced in North America goes to the construction industry. In Europe, about 50% of OSB is consumed for residential buildings [2]. OSB is widely used as a structural wood panel for floors (including subfloors and underlays), walls and ceilings. It is used for interior fittings, furniture, shuttering and packaging and also in the manufacture of I-joists, where it forms the web or support between two flanges of solid wood. The world capacity for OSB rose from less than 2 million m^3 (1996) to approximately 44 million m^3 in 2017 (Wood Based Panels International 2019). According to EN 300 (2006), four quality types of OSB are manufactured. OSB/3 represents the majority of European OSB production, accounting for approximately 85%, followed by OSB/2 with 10%, and OSB/4 with 5% [3]. The properties of these OSB types are different and should meet the standard requirements. There are many parameters that affect the panel properties, such as raw material species, strands dimensions and quality, panel structure, resin type and receipt, pressure schedule, *etc*. The OSB properties are directly related to the natural strength properties of the wood raw material used, which is not homogeneous. OSB production in different regions is presented in Figure 1 [3].

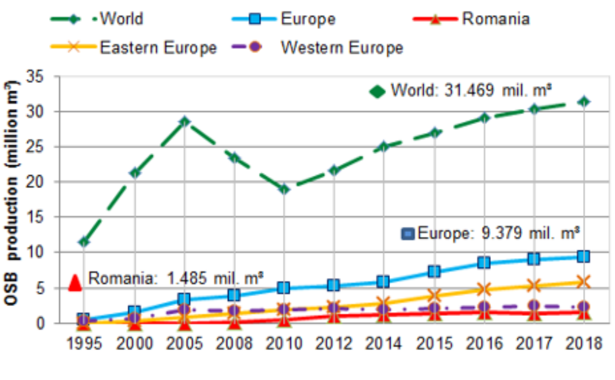

Figure 1. *OSB production in different regions [3].*

OSB is a widely used in building industry as sheathing and subflooring applications. OSB is intended for dry use applications and can swell substantially if the panels are exposed to moisture during construction or in service. OSB can replace plyvvood in most applications. OSB is an important structural panel in the world of industrial wood produets in terms of growth and performance. OSB was actually evolved from the waferboard, manufactured from square wafers.

Four grades of OSB are defined in EN 300 in terms of their mechanical performance and relative resistance to moisture. These are:
OSB/1 – General purpose boards and boards for interior fitments (including furniture) for use in dry conditions.
OSB/2 – Load-bearing boards for use in dry conditions.
OSB/3 – Load-bearing boards for use in humid conditions
OSB/4 – Heavy-duty load-bearing boards for use in humid conditions.

OSB production compared to plywood, particleboard, and MDF in UNECE region is presented in Figure 2 [4].

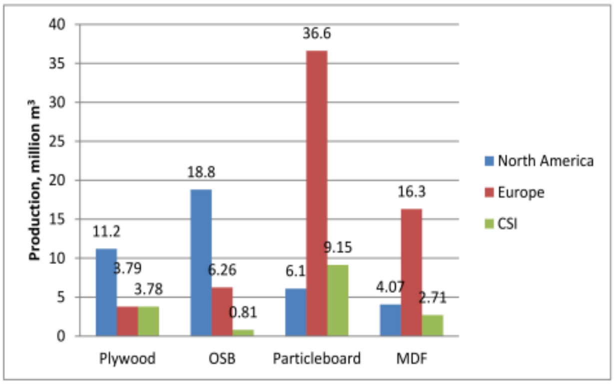

Figure 2. *OSB production compared to plywood, particleboard, and MDF in UNECE region [4].*

Mineral wool is the most common thermal insulation material used in light weight composites, and it is often placed between steel studs. Mineral wool is commonly utilised on the structure’s external walls and slab elements, but it is also employed within inner partitions and floors. It offers additional fire resistance to LSF elements since it is an incombustible material [5].

In this study, it was aimed to understand physical and mechanical properties of OSBs, which were used as a multi-purpose carrier material in the wood panel industry, especially in the construction industry, were used in the production of OSB in different proportions, by using rock wool in different proportions.

2. Materials and methods

2.1. Materials

Maritime pine (*Pinus maritima*) wood was used as raw material in the production of test plates. The strands of 0.6-0.7 mm thickness, 10-30 mm width and 100-120 mm length were obtained from round woods by mechanically chipping. The obtained chips were dried in dryer tubes with a humidity of 3% between 3-3.5 minutes. For the mat forming process, the chipboard was prepared in the 50x50 mm prepared laying vessel/trough. As an adhesive, 60% of 1.28 kg/m³ urea formaldehyde (UF) E2 glue was used, 9% of the total dry fiber weight. As a hardener, 1.1 kg/m³ $(NH_4)_2SO_4$ ammonium sulfate of 20% was used in the glue at the rates of core layer: 3%, surface layer: 1%. In the hot pressing process, the mats were hot pressed at 185-190 °C and 2.5 N/mm² pressure for 5 minutes with a final thickness of 18 mm. The test methods are givne in Table 1.

Table 1. *Test methods used in the experiments.*

Tests	Specimen size (mm)	Standard no	The requirement
Internal bond strength	50x50	TS EN 319	≥ 0,30 N/mm²
Bending strength	50x410	TS EN 310	≥ 10 N/mm²
Bending modulus	50x410	TS EN 310	≥ 1400 N/mm²
Thickness swelling	50x50	TS EN 317	20%
Free formaldehyde	2,5x2,5	TS EN 120	≤ 8,0 - ≤ *12*

The resulting OSB specimens with rockwool are presented in Figure 4.

Figure 3. *Hot pressing of OSB mat.*

Figure 4. OSB strands

2.2. Methods

Physical and mechanical properties of the OSB panels were determined according to European Norms (EN). One day thickness swelling (TS) test were performed on the ten specimens with dimensions of 50 mm x 50 mm according to the EN 317 standard (1993). The bending strength (MOR) and bending modulus (MOE) of the 10 OSB specimens with dimensions of 50 mm x 410 mm, (the average of 5 // and 5 ⊥ to the OSB surface) were tested according to the EN 310 standard (1993). The internal bond (IB) strength was determined on the ten specimens with dimensions of 50 mm x 50 mm according to the EN 319 (1993). The Free-formaldehyde emission of the specimens was determined according to the EN 120 standard.

3. Results and discussion

The average density of the test specimens produced with 18 mm thickness using maritime pine (*Pinus maritima*) wood was determined as 0.590 g/cm^3. The mean and standard deviation values of the mechanical and physical properties of the test boards obtained by using different proportions of rock wool in the middle layer in OSB/2 production are shown in Table 2.

Bending strength and bending modulus of the OSB specimens decreased with increasing rockwool content. The bending strength of the OSB specimens with 10 wt% rockwool content was found to be the same with the control OSB while the OSBs with 20% and 30% rockwool. As compared to the control OSB, The internal bond strength decreased with increasing content of the rockwool. This result showed that the bond performance between the wood strands and rockwool was negatively affected by the rockwool content. The thickness swelling of the OSB specimes decreased when the rockwool content increased to 20 wt%, while further increment in the rockwool content increased the thickness swelling. Formaldehyde emission of the specimens considerably increased with increasing content of the rockwool (Table 2).

Table 2. *Physical and mechanical properties of the OSB specimens*

Test method	Control OSB	Core layer with 10% rockwool	Core layer with 20% rockwool	Core layer with 30% rockwool
Bending strength (N/mm²)	12.93 (± 0.52)	12.97 (± 1.53)	11.46 (± 0.64)	10.78 (± 1,20)
Bending modulus (N/mm²)	2403 (± 224.05)	2193 (±152)	1997 (± 197)	1755 (± 178)
Internal bond strength (N/mm²)	0.35 (± 0.02)	0.32 (± 0.06)	0.28 (± 0.04)	0.22 (± 0.01)
Thickness swell (%) 24 h	15.12 (± 2.09)	13.92 (± 1.08)	14.48 (± 1.73)	21.41 (± 1.23)
Free formaldehyde emission (mg/100 g specimen)	13.25	12.18	9.04	9.59

4. Conclusions

The results of the present study showed that the thickness swelling and free-formaldehyde emission of the OSB specimens decreased with increasing rockwool content. The bending modulus of the specimens considerably decreased with increasing rockwool content while the 10 wt% addition of the rockwool content did not decrease the bending strength. Based on the test results, it was concluded that 10 wt% of rockwool can be used in the production of OSB without decreasing physical and mechanical properties.

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