Characterization tests for insulation boards made from corn cob and natural glues

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In recent years there has been a growing interest in developing news solutions for more ecologic and efficient construction, including natural, renewable and local materials, thus contributing in the search for more efficient, economic and environmentally friendly construction. Several authors have assessed the possibility of using various agricultural sub products or wastes, as part of the effort of the scientific community to find alternative and more ecologic construction materials.

Corn cob is an agricultural waste from a very important worldwide crop. Natural glues are made from natural materials, non-mineral, that can be used as such or after some modifications to achieve the behaviour and performance required. Two examples of these natural glues are casein and wheat flour-based glues that were used in the present study. Boards with different compositions were manufactured, having as variables the type of glue, the dimension of the corn cob particles and the features of the pressing process.

The tests boards were characterized with physical and mechanical tests, such as thermal conductivity (λ) with a ISOMET 2104 and 60 mm diameter contact probe, density (ρ) based on EN 1602:2013, surface hardness (SH) with a PCE Shore A durometer, surface resistance (SR) with a PROCEQ PT pendular sclerometer, bending behaviour (σ) based on EN 12089:2013, compression behaviour (σ_{10}) based on EN 826:2013 and resilience (R) based on EN 1094-1:2008, with a Zwick Rowell bending equipment with 2 kN and 50 kN load cells (Fig. 1), dynamic modulus of elasticity (E_d) with a Zeus Resonance Meter equipment (Fig. 5) based on NP EN 14146:2006 and water vapour permeability (δ) based on EN 12086:2013.

The various boards produced were characterized according to the tests and the ones with the best results were C8_c8 (casein glue, grain size 2,38-4,76 mm, cold pressing for 8 hours), C8_c4 (casein glue, grain size 2.38-4.76 mm, cold pressing for 4 hours), F8_h0.5 (wheat flour glue, grain size 2.38-4.76 mm, hot pressing for 0,5 hours), FEV8_h0.5 (wheat flour, egg white and vinegar glue, grain size 2.38-4.76 mm, hot pressing for 0,5 hours) and $FEVH_6$8_c4 (wheat flour, egg white, vinegar and 6 g of sodium hydroxide glue, grain size 2.38-4.76 mm, cold pressing for 4 hours).

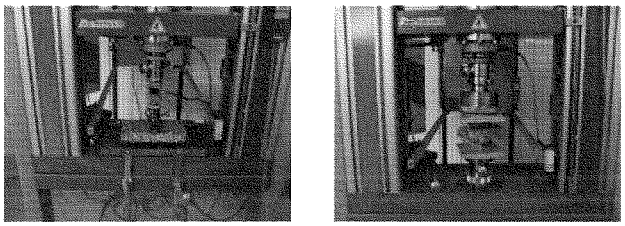

Figure 1: Zwick Rowell bending equipment with 2 kN (left) and 50 kN (right) load cells

Taking into account the various boards produced and respective test results the type of glue and the pressure and pressing time are very important factors which strongly influence the final product.

The results obtained confirmed the initial hypotheses that these boards have potential as a thermal and, eventually, acoustic insulation material, to use as coating or intermediate layer on walls, floors or false ceilings. This type of board has a high mechanical resistance when compared with traditional insulating materials, as can be seen in (Table 1).

Table 1: Comparison between the board with corn cob and natural glue which showed better results ($FEVH_6 8\_c4$) and some traditional insulation materials

Insulation boards	Board with corn cob and natural glue	ICB	XPS	EPS	Rockwool
Thickness (mm)	31	10 a 300	30 e 40	20 a 100	30 a 100
ρ (kg/m^3)	502	110 a 120	30	20	145
λ (W/m.ºC)	0.114	0.037 a 0.040	0.035	0.036	0.038
δ (mg/m.h.Pa)	0.09	0.015 a 0.045	0.004 a 0.009	0.009 a 0.020	0.400
σ (kPa)	1043	≥ 130	-	150	-
σ_{10} (kPa)	1690	≥ 110	200	100	≥ 45
Technical details	-	Sofalca	Wallmate / Floormate	CIN	CIN

The integrity of these boards seems to be maintained even in higher humidity environments. However, due to biological susceptibility and sensitivity to water, they would be more adequate for application in dry interior conditions.