



**SB13  
Graz**

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**POLITECNICO  
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# **ENVIRONMENTAL IMPROVEMENT OF BUILDING INSULATING CLADDING SYSTEM**

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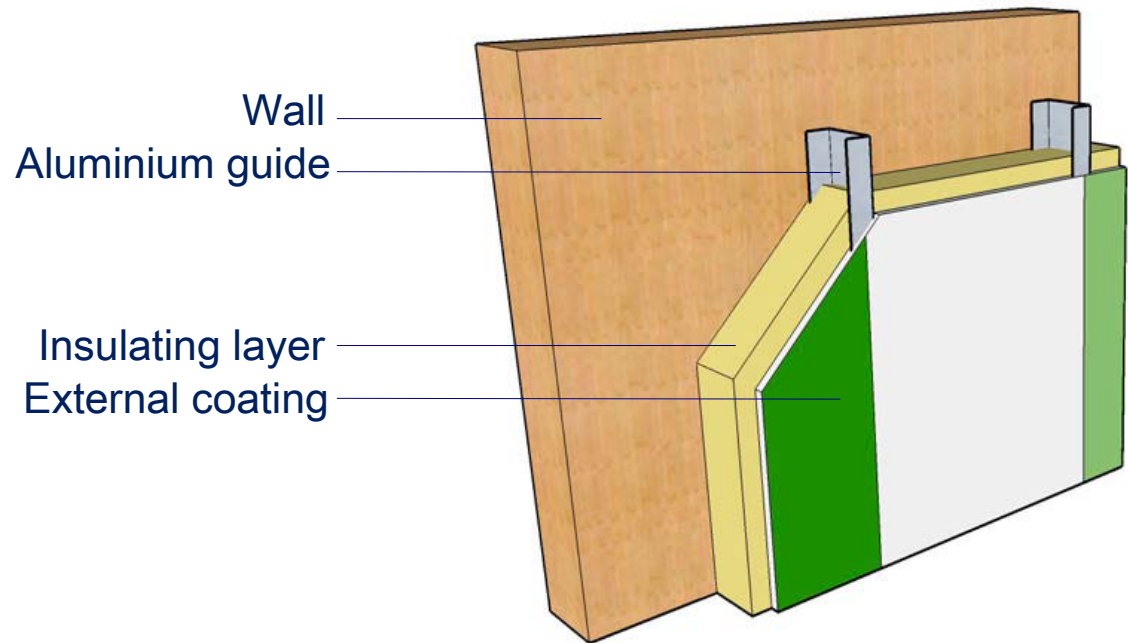
# Introduction



The present work aims to improve the thermal and environmental performances of a **building cladding system**.

The research focuses on the analysis of the **insulation layer** and carries on the development of a **new composite material** suitable to replace the actual products.

The result is the development of a new **sustainable** and **smart** insulating material.



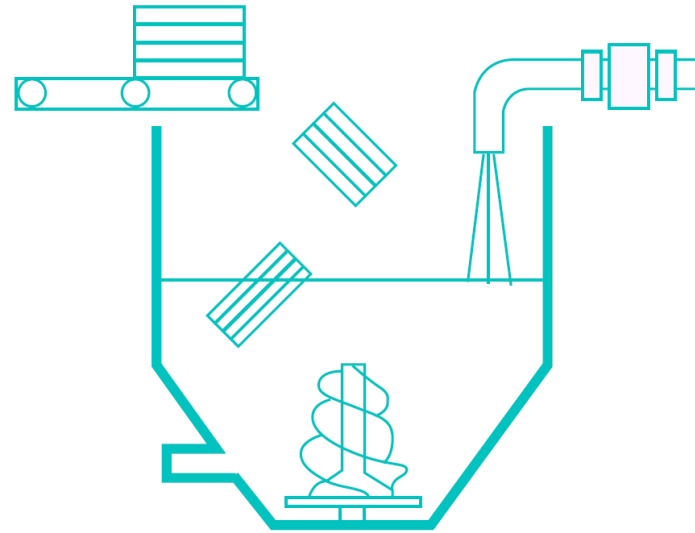
# Materials

## Cardboard scraps



**Paper recycling** is a well consolidated industrial process which gives undeniable economical and environmental advantages.

In building industry, taking advantage of **insulating function of cellulose fibres**, paper scraps has been recently employed as thermo-acoustic insulating material.



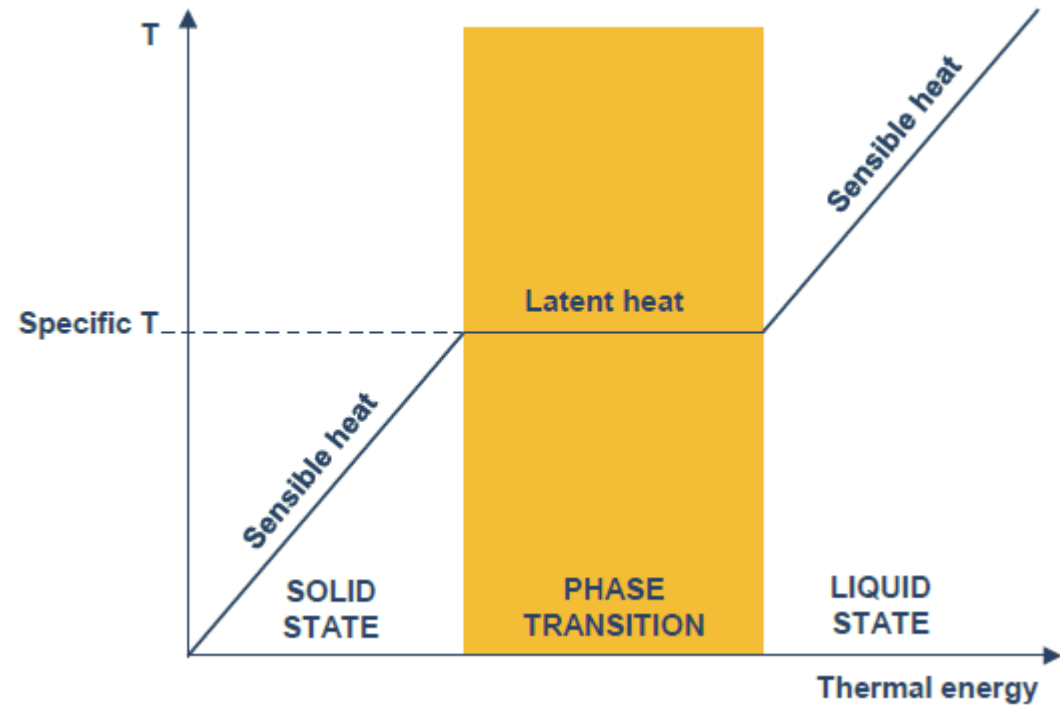
# Materials

## PCMs



The role of PCMs inside insulating material is to **reduce the heat transfer** through the perimeter walls in order to reduce **energy consumption** in summer.

Those substances have **high heat storage capacity** that can be set at useful temperatures in accordance with their phase transition temperature. PCMs thermal storage should be activated when temperatures exceeds the comfort zone.

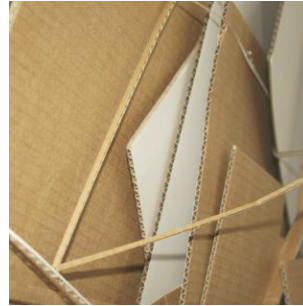




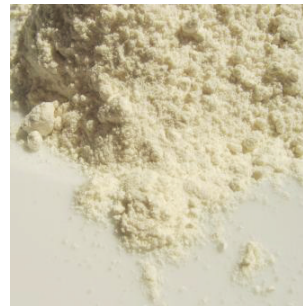
# Production process

Cardboards derived from industrial scraps has been processed with water into the **pulper machine** (a). A wet pulp has been obtained (b) and chemical substances, in **liquid** (d) or **powder** (c) form, has been added into the mixture in order to enhance resistance and insulating properties of cellulose fibers.

The wet pulp chemically modified has been placed into **mold** and processed in a **heater** in order to drain water (e). Settings in time and temperatures vary with material compositions and quantities. As result a dry **solid panel** has been obtained (f).



*CELLULOSE MATRIX*



*FUNCTIONAL ADDITIVES*



*COMPOSITE MATERIAL*

# Properties

## Durability

In order to preserve the sustainability of a product it is necessary to ensure an adequate life time.

In order to improve fire resistance and confer fungicidal effect, an addition of **30% of Borate Salts** has resulted adequate.

In order to improve water resistance, an addition of **15% of Basoplast Basf** has resulted effective.



*BORATE SALTS*



*BASOPLAST BASF*



# Properties

Lightness and resistance

Flexural strength [kPa]				
282,95	170,75	375,8	650,50	390,25
Density [kg/m3]				
145	180	215	260	215
A. Expanded perlite panel with cellulose fibers	B. Porous panel of cellulose fibers and PCMs	C. Perforated panel of cellulose fibers and PCMs	D. Expanded perlite panel	E. Compact panel of cellulose fibers and PCMs





# Properties

Thermal conductivity

Thermal conductivity - [W/mK]				
1,10	1,15	1,220	1,31	1,38
PIZ Cladding system U value [W/m²K]				
0,050	0,052	0,055	0,060	0,063
A. Expanded perlite panel with cellulose fibers	B. Porous panel of cellulose fibers and PCMs	C. Perforated panel of cellulose fibers and PCMs	D. Expanded perlite panel	E. Compact panel of cellulose fibers and PCMs



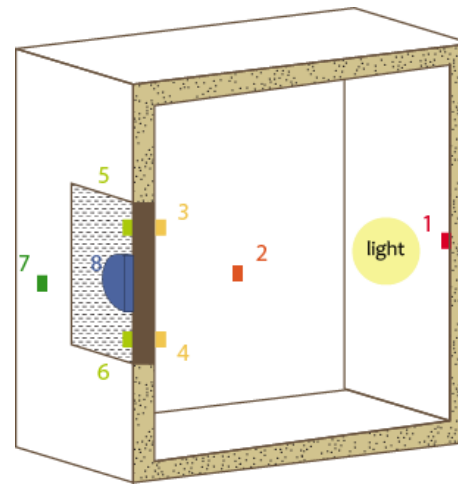


# Properties

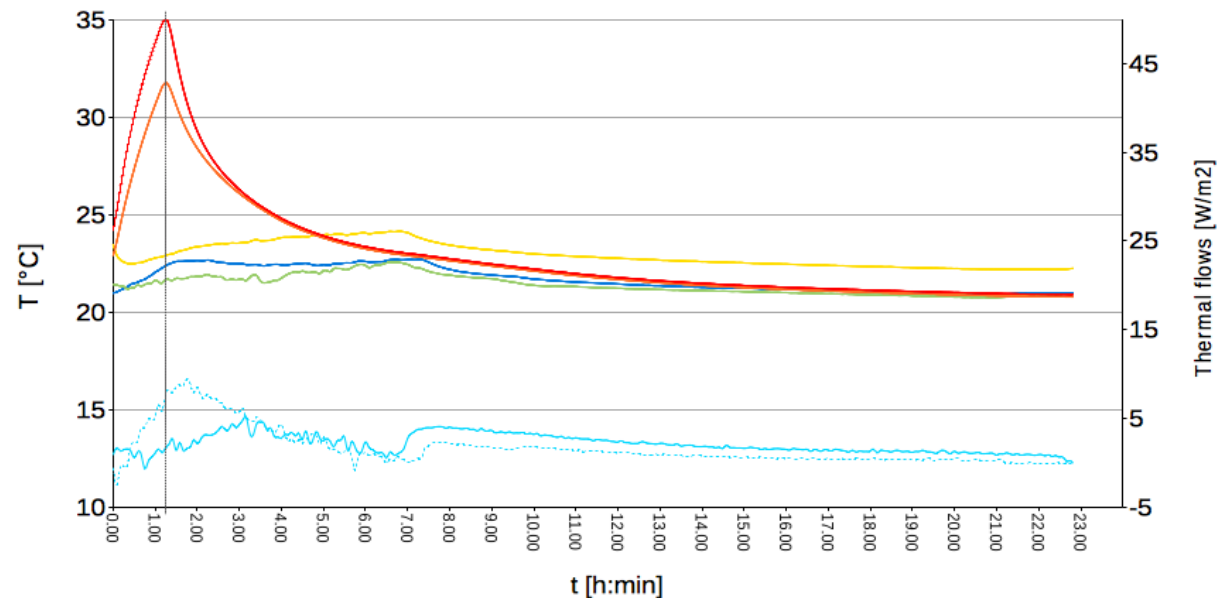
## Thermal inertia

The PCMs power to improve the environmental sustainability during the product working phase has been validated by **laboratory tests**.

A **thermostatic chamber** has been constructed and **temperature variation** of typical summer days has been reproduced switching a lamp inside it. Samples of insulating material have been placed on the perimeter wall and, using a **heat flows** probe, the insulating capacity of each panel has been compared.



- 1 average internal-back temperatures
- 2 average internal-front temperatures
- 3 Panel internal temperatures
- 4 Panel internal temperatures
- 5 Panel external temperatures
- 6 Panel external temperatures
- 7 average external temperatures
- 8 thermal flows

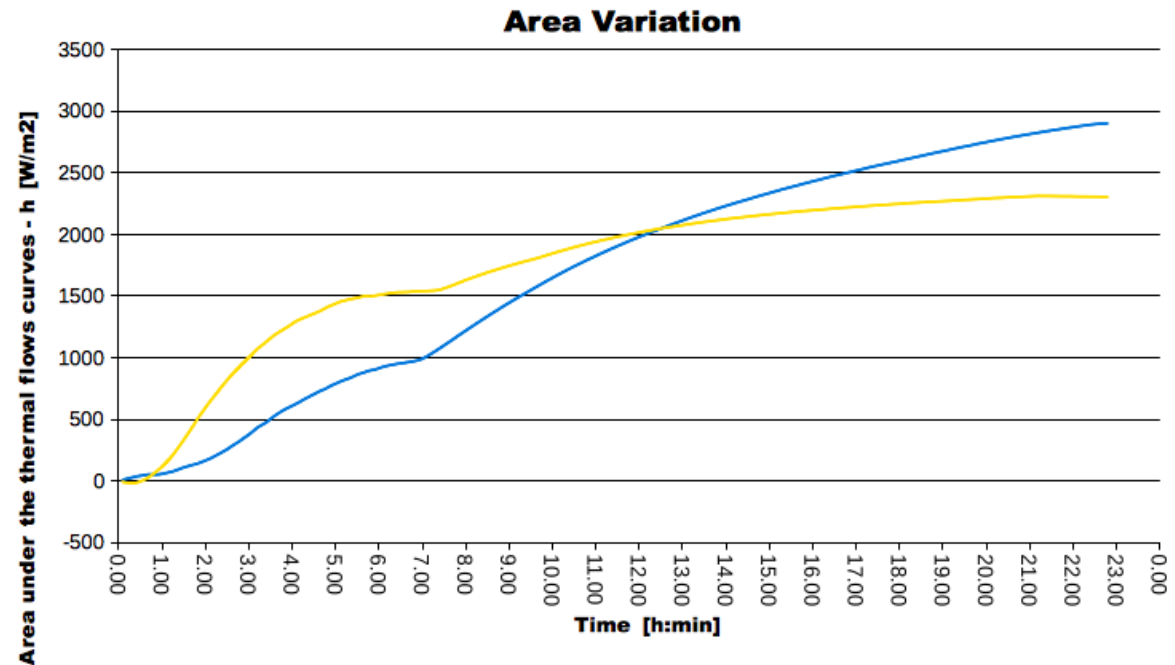


# Properties

## Thermal inertia

Calculating the **area under the thermal flows curves**, it is possible to compare the **amount of thermal energy** which passes through the panel in a definite period time.

Cellulose-PCM panel with phase transition at  $28^{\circ}\text{C}$  has the better performance up to 12:30 hours of thermal test. After that time Perlite panel acquires better results thanks to its better thermal conductivity. Cellulose-PCM panel with phase transition at  $26^{\circ}\text{C}$  gives a good insulation till 3:30 hours of thermal tests.



The method adopted for **developing a new building insulating panel** in accordance with sustainable requirements has been described. The following properties have been evaluated:

DENSITY  
FLEXURAL STRENGTH  
THERMAL CONDUCTIVITY  
THERMAL INERTIA

Thermal tests suggest that PCMs could be effective for the **reduction of cooling systems energy consumption** during summer periods.

The new composite material looks promising to be a **good substitution of perlite panels** commonly used in building insulation both in winter and summer conditions.

Starting from those results next step will be the evaluation of the **environmental impact** of the new product through the LIFE CYCLE ASSESSMENT (LCA).



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**THANK YOU**

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