LIFE-Repolyuse I REcovery of POLYurethane for reUSE in eco-efficient materials

Design and Manufacture of a Sustainable Lightweight Prefabricated Material Based on Gypsum Mortar with Semi-Rigid Polyurethane Foam Waste

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Project co-funded by the LIFE Programme
of the European Union (LIFE16 ENV/ES/000254)

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PRESENTATION

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01 INTRODUCTION

This work is centered on the physical-mechanical characterization of a new lightweight plate for use in internal ceilings, and the demonstration of its viability on an industrial scale, which would permit its application in the future.

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PROBLEM

Plastics production

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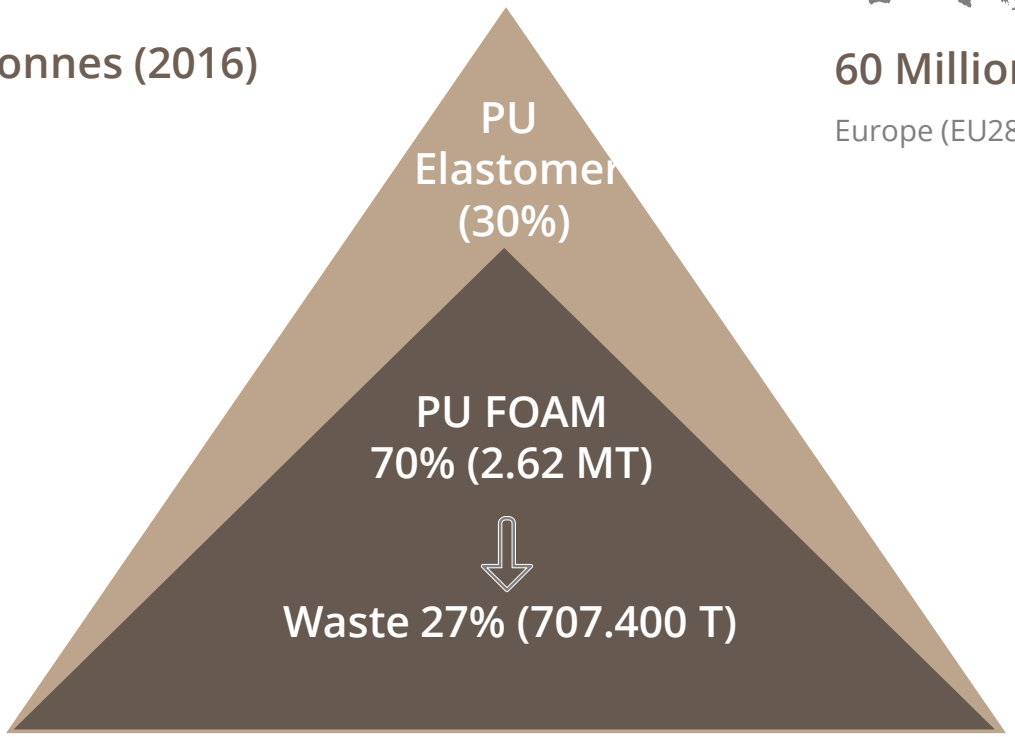
335 Million Tonnes (2016)

World 2016

60 Million Tonnes (2016)

Europe (EU28+NO/CH) 2016



49.9 MTn

Plastic Demand in Europe 2016

7.5%

Polyurethane Demand 2016

27.3% Landfill

193.120 Tonnes

31.1% Recycling

219.294 Tonnes

41.6% Energy recovery

294.278 Tonnes

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02

PROJECT LIFE-REPOLYUSE

REcovery of POLYurethane for reUSE in eco-efficient materials

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PROJECT LIFE-REPOLYUSE

REcovery of POLYurethane for reUSE in eco-efficient mat

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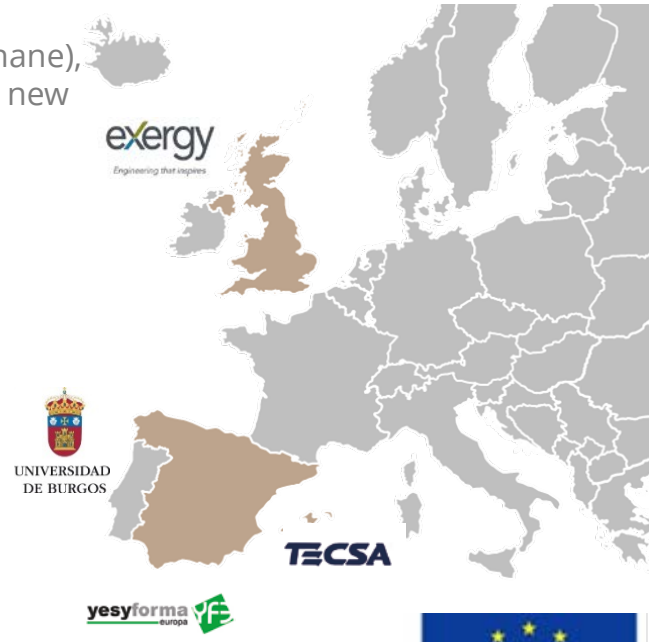
What is Life-Repolyuse?

LIFE-REPOLYUSE addresses the problem of the management of plastic waste (polyurethane), through the use of innovative techniques of reduction and reuse, integrating them into new construction materials, in order to prolong their useful life.



Partners

UBU / EXERGY / TECSA / YESYFORMA

Total Project duration

36 months

Total budget

1.289.434 €

Results

- Reduction of pollutants emitted into the atmosphere (dioxins, HCB, fine particles) □10%
- Reduction of extraction of natural gypsum resource □34%
- Reuse of foamed polyurethane waste in Europe □75,000 Tn / year
- Average manufacturing cost savings of the new prefabricated → 18%
- Energy saving in a building → 135 kwh

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PROJECT LIFE-REPOLYUSE

REcovery of POLYurethane for reUSE in eco-efficient mat

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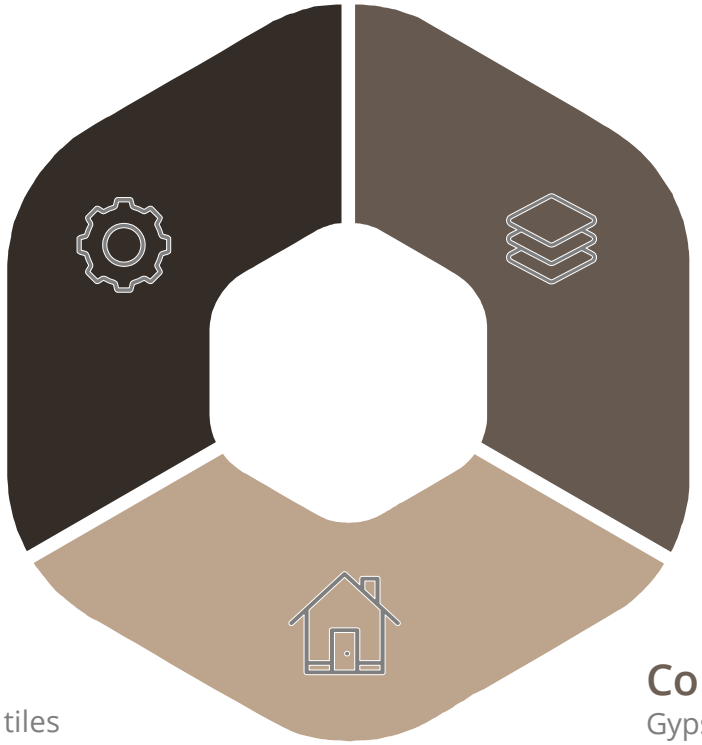
PU Waste

Reuse in new gypsum-PUW tile



Gypsum-PUW Product

Manufacturing

Deconstruction

Waste from Gypsum-PUW tiles

Construction

Gypsum-PUW tiles for ceiling in real demo-site's

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03 RAW MATERIALS

The raw materials needed to make gypsum boards are:
Gypsum, Polyurethane Foam Waste (PFW) and water.

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RAW MATERIALS

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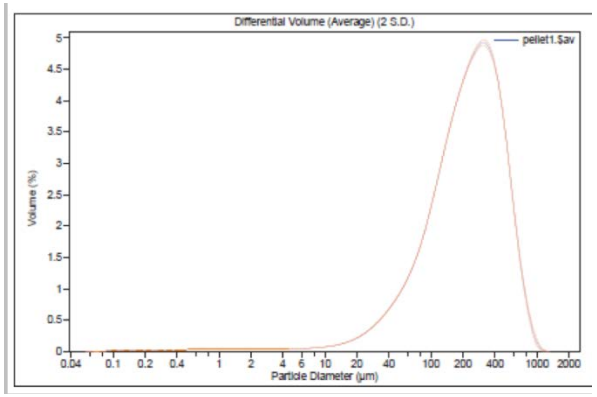
Gypsum conglomerate A/14/3.5 (Standard EN 13279-1)

- Initial setting period of over 14 minutes
- Compression resistance of ≥ 3.5 N/mm²
- Purity value of 92%

Polyurethane Foam Waste (PFW)

- Origin: Automobile industry.
- After shredding granulometry between 0-0.5 mm
- Real density 1080 kg/m³
- Bulk density 72 kg/m³



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RAW MATERIALS
Polyurethane Foam Waste

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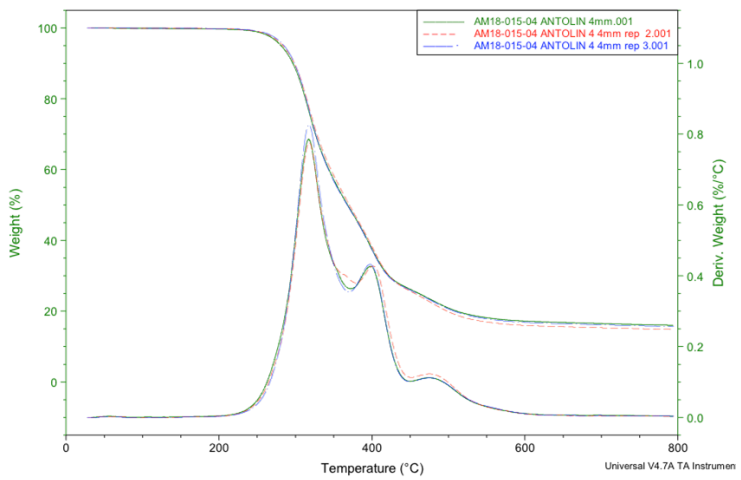
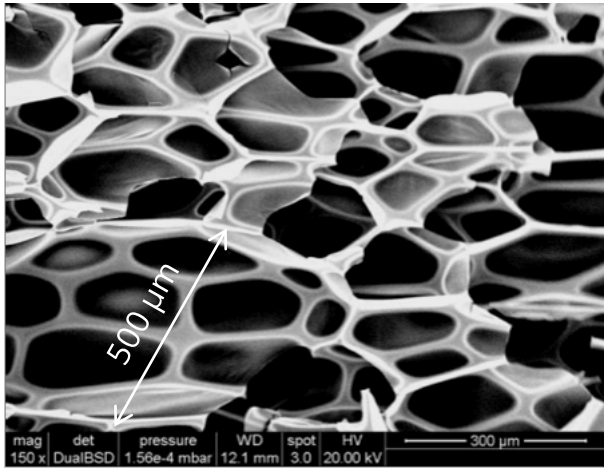
PFW:

- 27 min/Kg
- 0.68 kWh/ Kg
- TGA: 300 ºC





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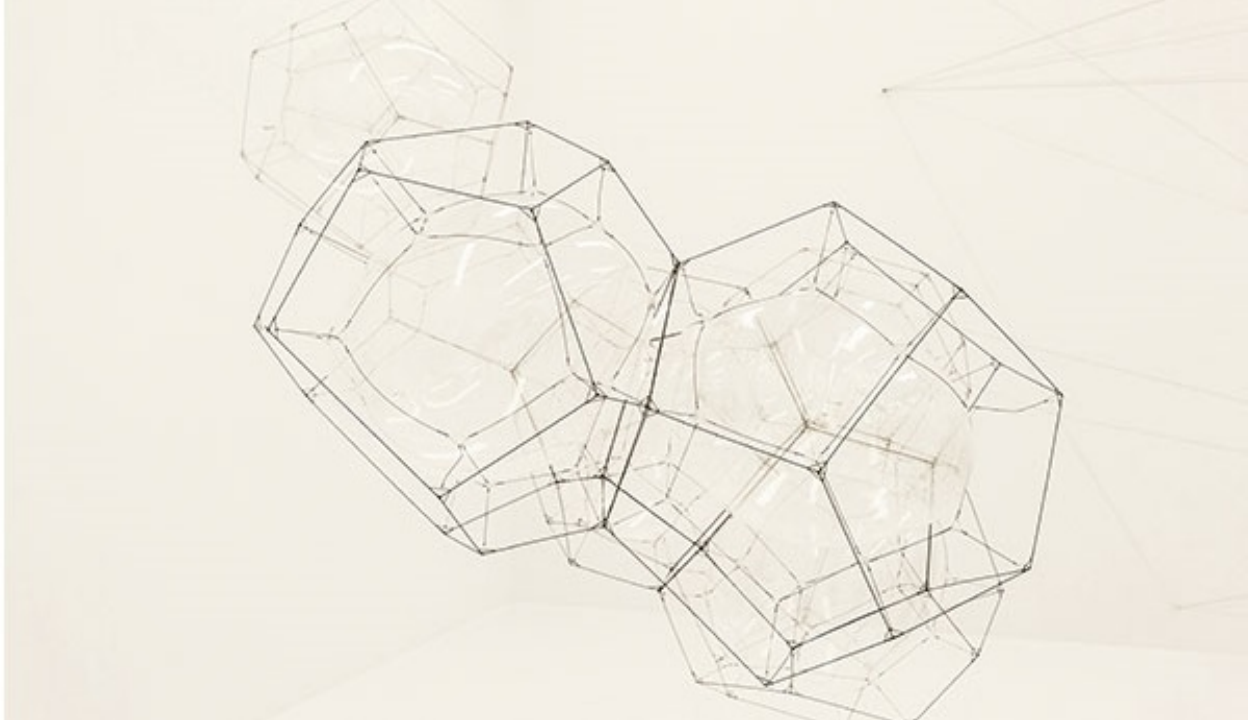

04 EXPERIMENTAL PROCEDURE

The procedure to make the gypsum ceiling tiles (Y Board) consist of the progressive substitution of gypsum with Polyurethane Foam Waste (PFW) by volume.

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EXPERIMENTAL PROCEDURE

Test methods

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Different mixtures

Blends were prepared substituting by volume different proportions of gypsum for PUW

Samples	By volume Gypsum/PUW	By weight (gr) Gypsum/PUW
Y0	1/0	1000/0
Y0.5	1/0.5	1000/27.8
Y1	1/1	1000/55.5
Y2	1/2	1000/111.0
Y3	1/3	1000/166.5
Y4	1/4	1000/222.0

Test methods

- Bulk density
- Flexural strength
- Water absorption
- Fire reaction
- Thermal conductivity

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EXPERIMENTAL PROCEDURE

Specimen preparation

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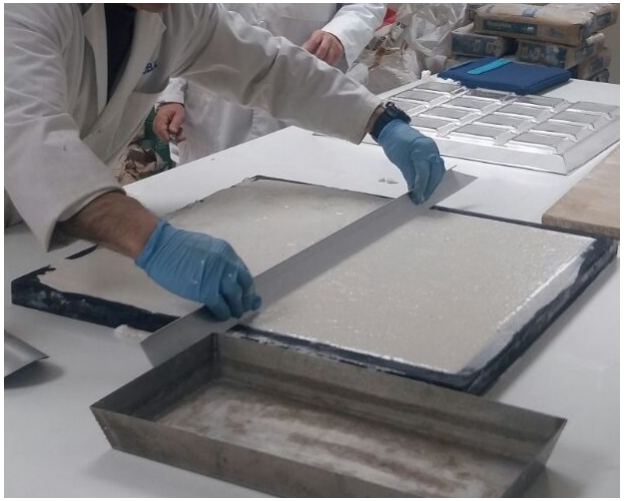

Mixture

- Gypsum
- Polyurethane Foam Waste (PFW)
- Water

Curing

- Temperature 24 ºC
- Relative humidity 50 ± 1% for 7 days

Drying

- To constant mass of 40±2ºC

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05 RESULTS AND DISCUSSION

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Bulk Density

Results at 7 days (Kg/m³)

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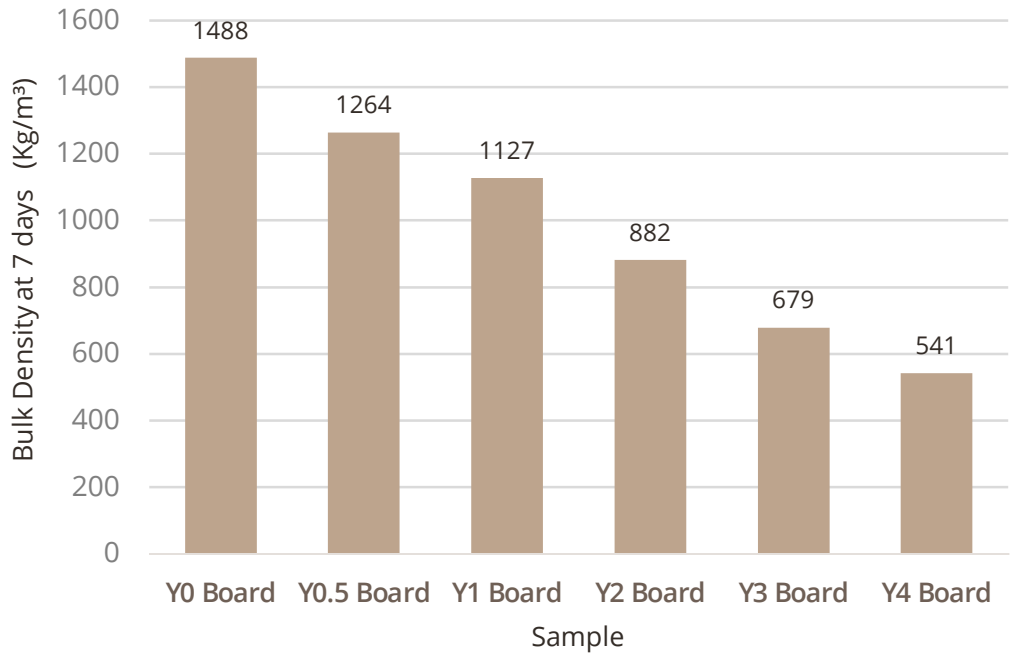
64%

As the volume of PU in substitution of gypsum increases, there is a drop in density.

In sample Y4 board (1 part gypsum and 4 PU), 64% reduction



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Flexural strength
Results

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Optimal Samples:

- *Y0.5 Board*
- *Y1 Board*
- *Y2 Board*

Y2 Board. During the flexural test

UNE 14246:2007 Standard

Y2 Board. After testing

- Optimal results were obtained
- Test piece without imprint

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Total Water Absorption

Results (Avg.%)

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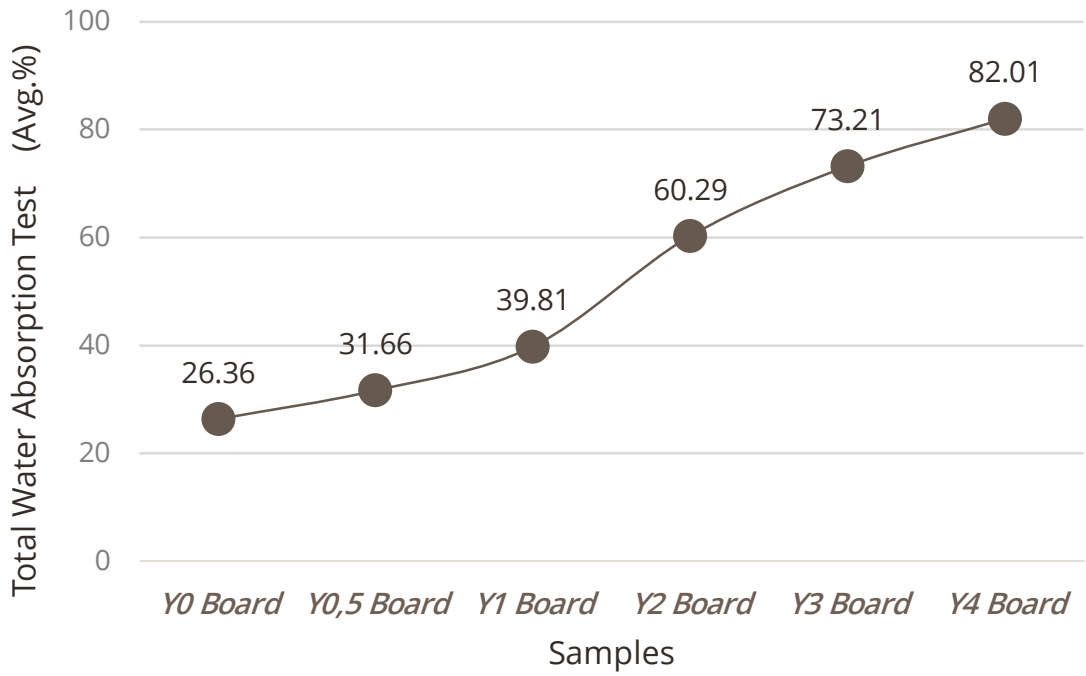
60%

The increase of waste present in the mixture implies a higher rate of water absorption.

The absorption capacity increased considerably in the case of the Y2 Board (60%).



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Fire Reaction Test

Results of the non-combustibility test

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Parameter	Sample Y1	Sample Y2
Temperature rise of furnace (°C)	0.6	2.4
Duration of sustained flaming (s)	<5	<5
Loss of mass (%)	26.1	27.1
Euroclass Classification	A1	A2
CTE-D-SI	(B-s2-d0)	(B-s2-d0)

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Thermal conductivity
Results

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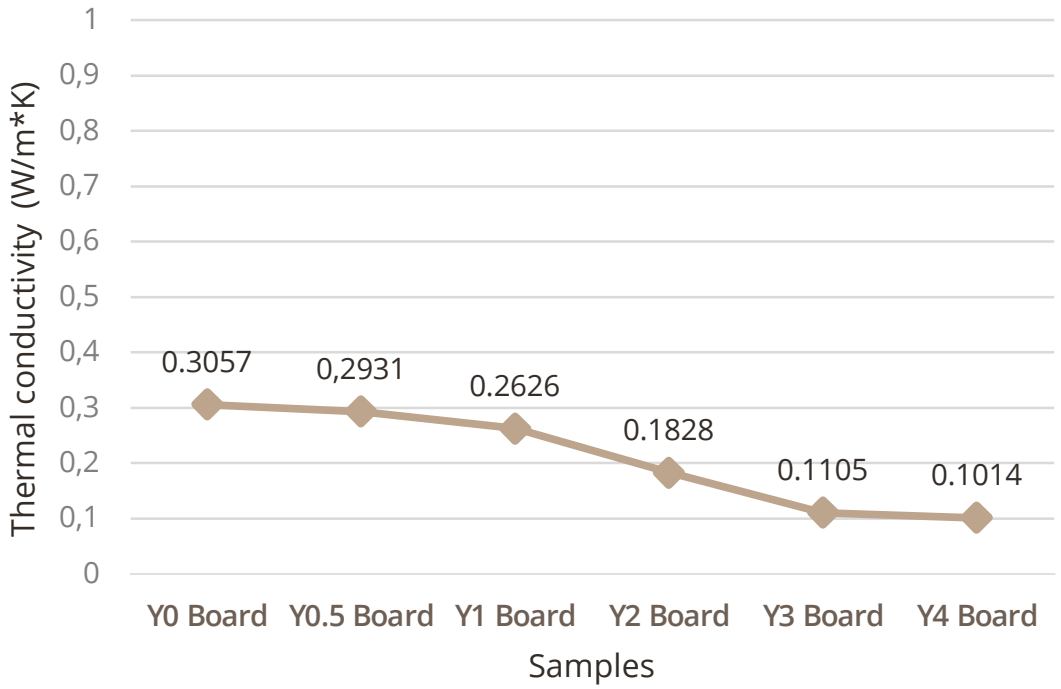
66%

Decrease in thermal conductivity as the amount of PUW increases

The thermal conductivity decrease considerably in the case of the Y2 Board (66%).



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Real-scale Simulation of a Real Industrial Process

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PUW Origin

PUW Arrival

Volume reduce 90%

The PU wasteis compacted to reduce its volume up to 10 times

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Real-scale Simulation of a Real Industrial Process

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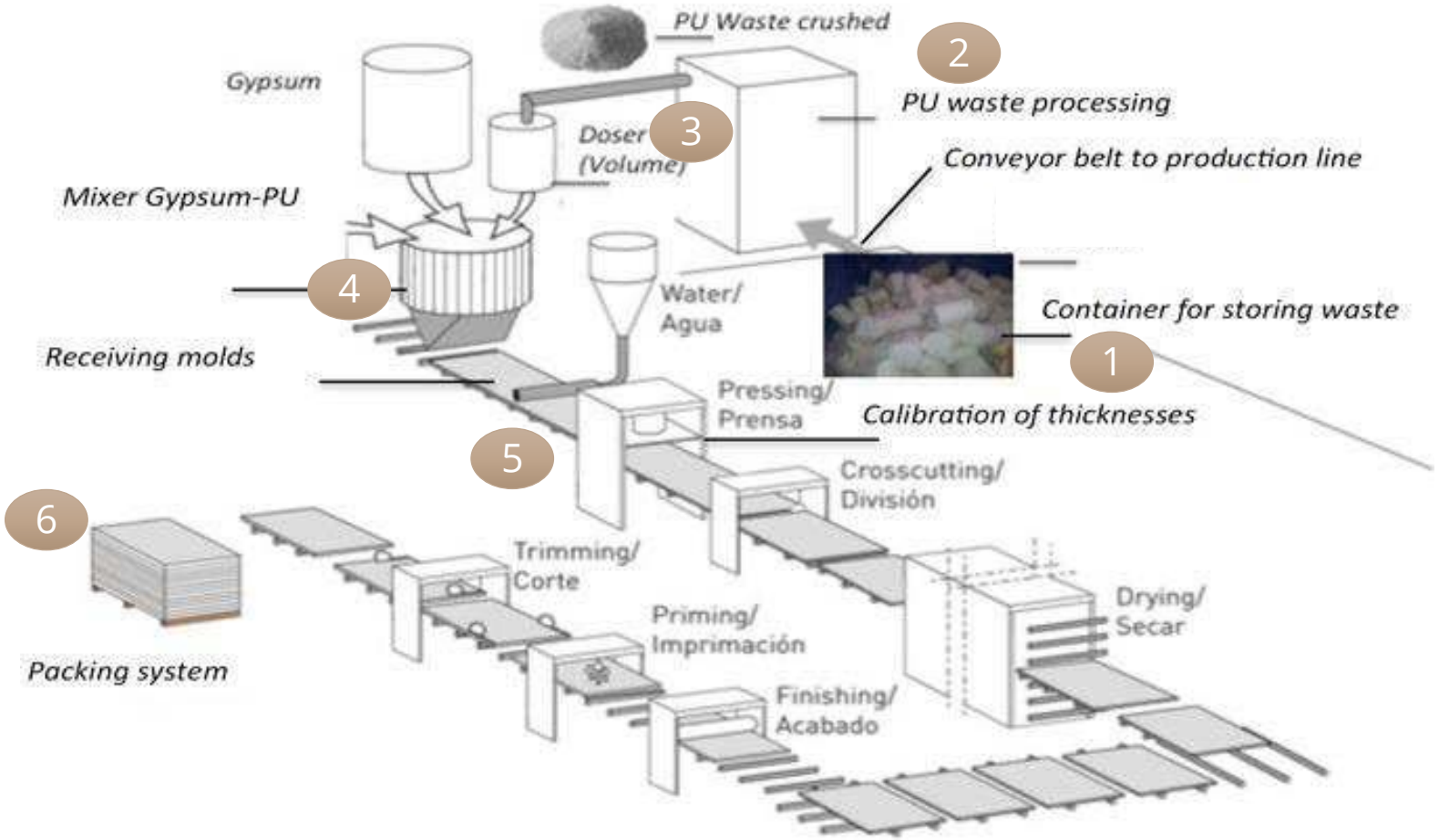

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Real-scale Simulation of a Real Industrial Process

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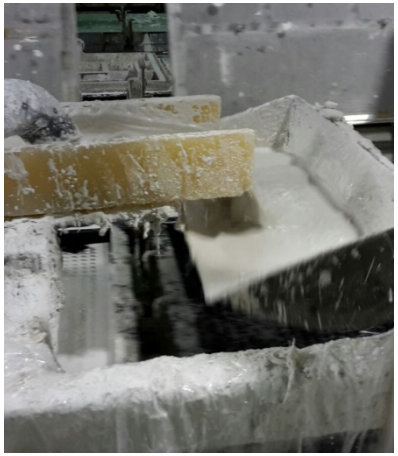
01 Mixture

02 PUW processing-03 Doser



04 Mixer

05 Tile cast

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Real-scale Simulation of a Real Industrial Process

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06 Processing

07 Storage

07 Packing

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06 CONCLUSIONS

Conclusions after the experimental process.

CONCLUSIONS

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Reduction in the bulk density

Is greater when larger amounts of waste are included in the final mixture.

Flexural Strength test comply with the tiles standard

Although the material's strength is weaken by the waste, sample (Y2) results obtained in the Flexural Strength test comply with the tiles standard.

Fire test

Gypsum ceiling tiles Y0.5, Y1 and Y2 have the positive results in the reaction fire test, according to the Eurocod which guarantees the safety of the material for use in ceilings

Real-scale industrial simulation

The possibility of reproducing the process with potential manufacturers of prefabricated gypsum has been shown. By doing so, sustainability in the management of plastic PU waste in the construction sector is encouraged.

Absorption

The tiles water absorption rate increases as the presence of PUW also increases. This is due to the cellular structure of PUW, which encourages water absorption

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THANK YOU VERY MUCH

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