WoodRuB

UTILISATION OF RECOVERED WOOD AND RUBBER FOR ALTERNATIVE COMPOSITE PRODUCTS

LIFE09+ ENV/ES/454

WoodRub project

Project title: WoodRub-Utilization of recovered wood and rubber for alternative composite products

Funding programme: LIFE+09/ENV

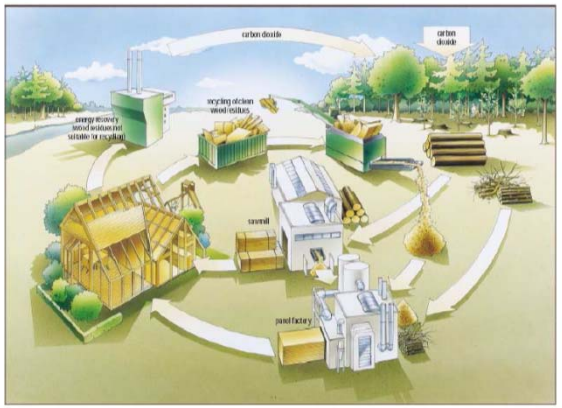
Duration: 36 months (start date: 1.9.2010)

Participants:
AIDIMA - ES
AUTH-LFU - GR
BRUNEL - UK
COSMOB - IT
ACCIONA - ES
SONAE R&D - DE
KERIDIS - GR
MARCHE MULTISERVIZI - IT
ENJILY - UK

Coordinator: AIDIMA (Wood, Furniture and Packaging Technology Institute), Valencia, Spain

Objective

- **The development, testing and demonstration of innovative environmental friendly products made from recycled wood and recycled rubber from tires**



As **secondary objectives** the project intends to:

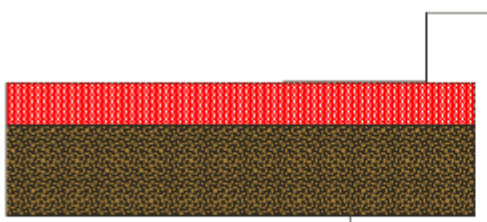
- provide wood waste managers and rubber waste managers a **novel end of life route for their products** and public and private construction entities a **new environmental friendly product**
- provide a **solution for the decrease** of the unutilized amounts of wood and rubber **waste**
- **increase the carbon storage** in buildings by replacing other building materials which are less environmentally friendly with these innovating products and towards carbon storage and emission, both in production processes and raw material use

WoodRub prototypes

WoodRub prototype	Intended use
WoodRub ACOUSAN	Highways facing
WoodRub ACOUFRAME	Acoustic walls (offices, residential buildings), Work walls (acoustic barriers)
WoodRub PLAYMAT	Playground
WoodRub SAFETYMAT	Anti-slip floor
WoodRub PATH	Garden path
WoodRub URBAN	Bench, Bin, Flower pot
WoodRub BRICKS	Internal walls

WoodRub prototypes using mixture of recycled materials

WoodRub PLAYMAT: Playgrounds



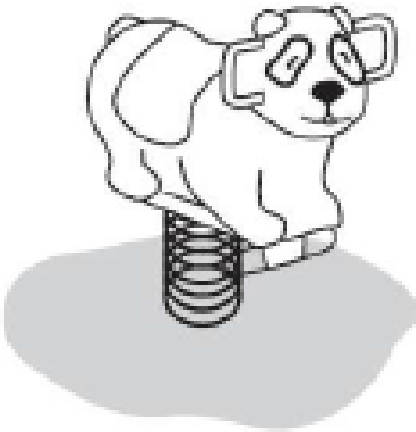
EPDM + PU Resin

EPDM (rubber) ≡ Ethylene propylene diene monomer rubber

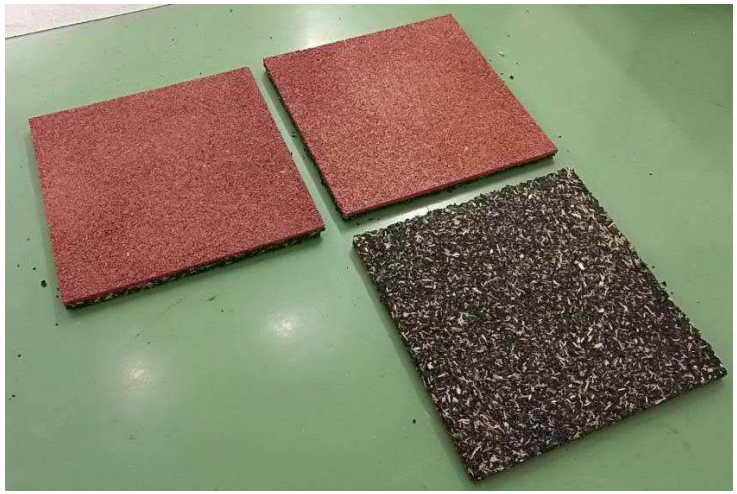
1 cm

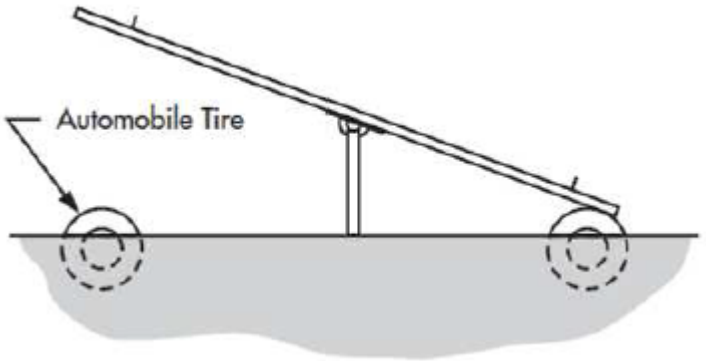
Wood particles + Rubber particles + PU Resin (medium size)

2 cm

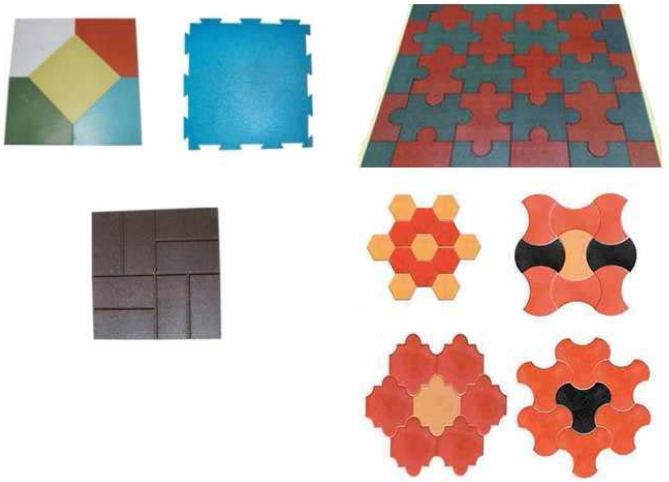


Animal Spring Rocker





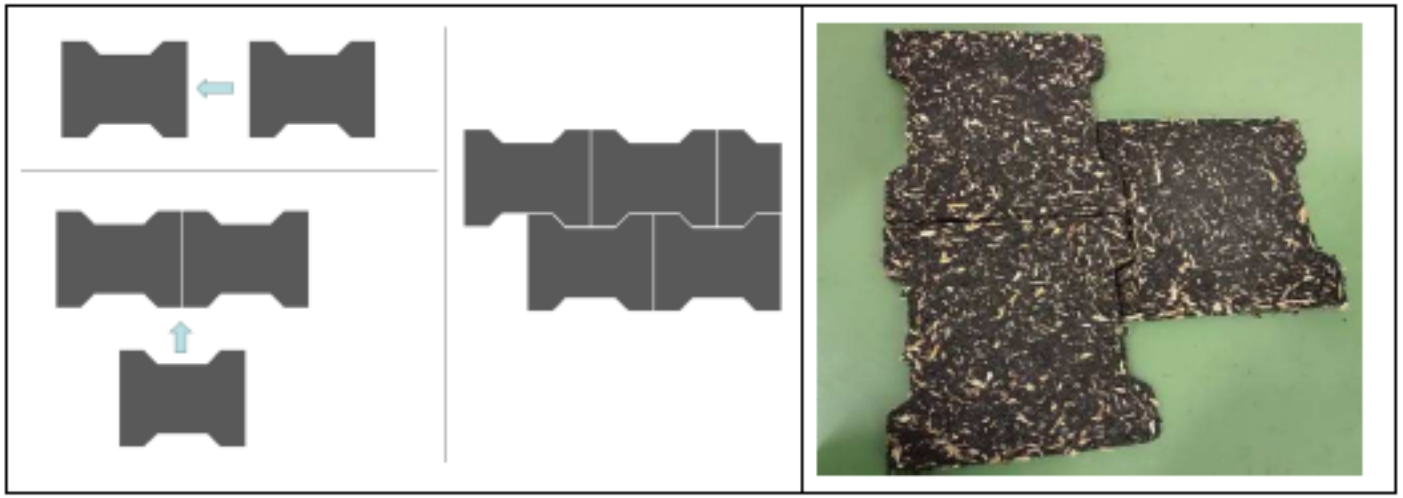
WoodRub PATH: Pathways



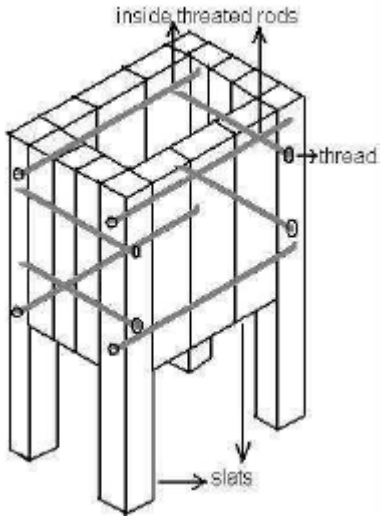
Material:

- Wood 10% + Rubber (small or medium sized)

- Resin



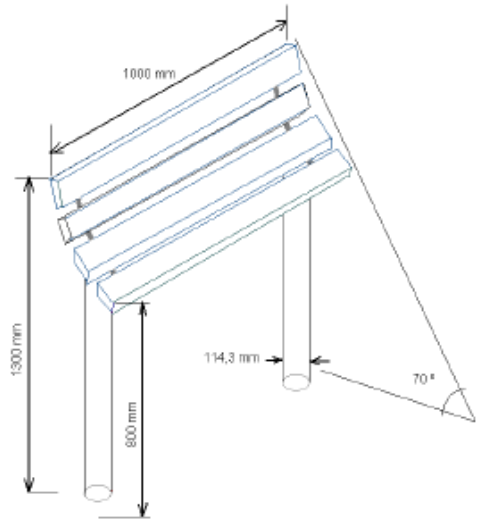
WoodRub URBAN: Outdoor bin



Particleboard slats

LABEL	W50	W70	
WOOD	50%	70%	
LABEL	BP	SP	
RUBBER DIAMETER	4-2 mm	Dust-1 mm	
LABEL	50	70	
HYDRAULIC PRESS	50 Kg/cm^2		
LABEL	10	10	
PMDI	10%	10%	of total particles
WATER	20%	20%	of PMDI

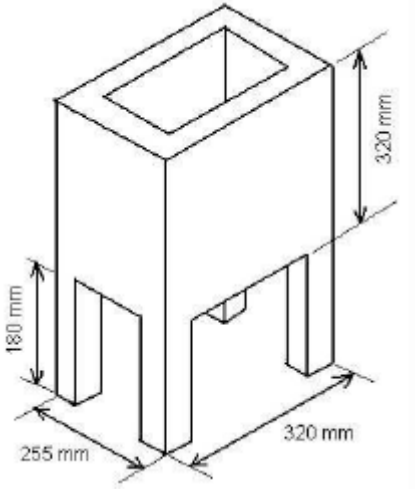
WoodRub URBAN: Outdoor bench back



Particleboard slats

LABEL	W50	W70	
WOOD	50%	70%	
LABEL	BP	SP	
RUBBER DIAMETER	4-2 mm	Dust-1 mm	
LABEL	50	70	
HYDRAULIC PRESS	50 Kg/cm^2		
LABEL	10	10	
PMDI	10%	10%	of total particles
WATER	20%	20%	of PMDI

WoodRub URBAN: Flower pot



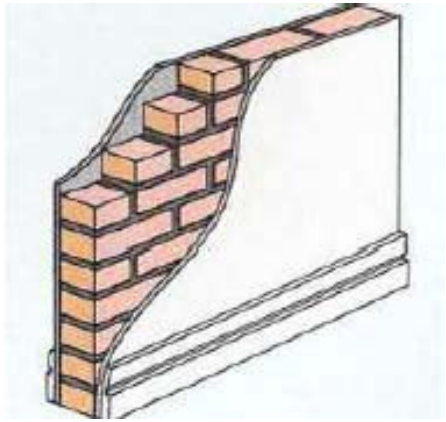
Particleboard slats

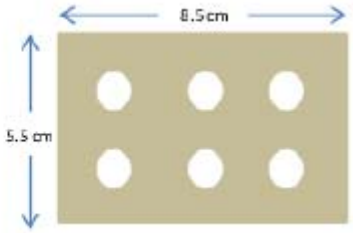
LABEL	W50	W70	
WOOD	50%	70%	
LABEL	BP	SP	
RUBBER DIAMETER	4-2 mm	Dust-1 mm	
LABEL	50	70	
HYDRAULIC PRESS	50 Kg/cm^2		
LABEL	10	10	
PMDI	10%	10%	of total particles
WATER	20%	20%	of PMDI

WoodRub BRICKS: Bricks

Material:

- Large fractions of wood and rubber particles
- Reduced rubber material containing textiles
- Gypsum + water



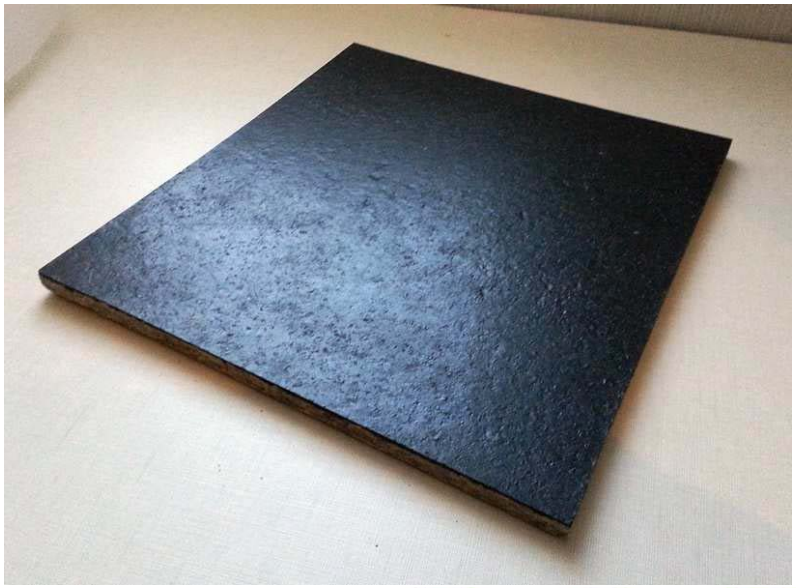


WoodRub prototypes without mixture of recycled materials

WoodRub SAFETYMAT: Anti-slip deck

Material:

- Recycled particleboard
- Sintered (3 mm thick) rubber layers

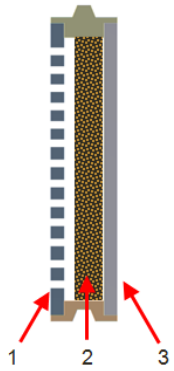


WoodRub ACOUFRAME: Acoustic barrier for highways

Material:

- Recycled particleboard (drilled and reflective layers)
- Rubber particles + PU resin (absorbent layer)

Acoustic Barrier Module - Components



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- DRILLED LAYER (PARTICLEBOARD)

* It allows pass the sound

$S_{DRILLED} / S_{TOTAL} > 30\%$

2

- ABSORBENT LAYER (RUBBER)

α = 0-1 (higher best)

$$\alpha = \frac{E_2}{E_i}$$

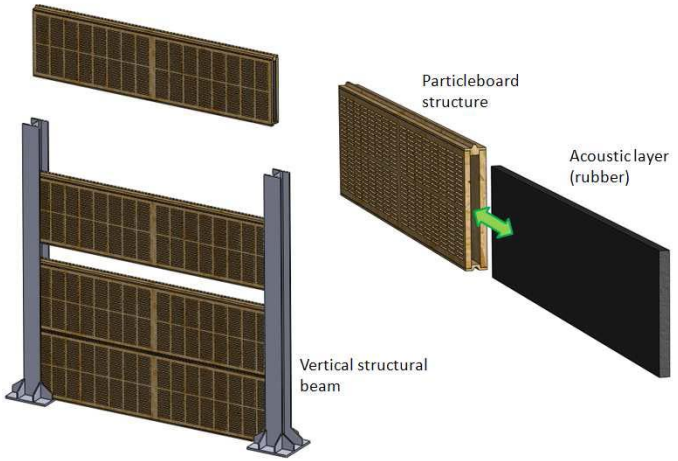
3

- REFLECTIVE LAYER (PARTICLEBOARD)

R ≥ 20

Minimum superficial density

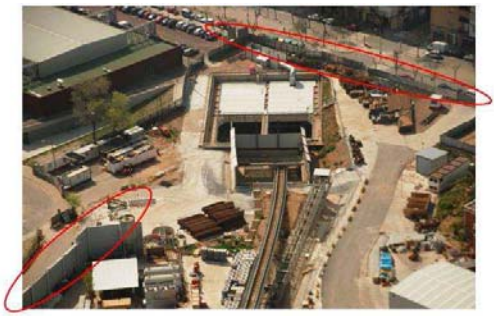
20kg/m²

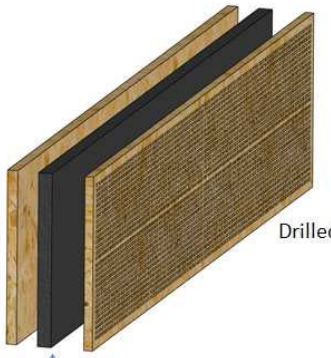


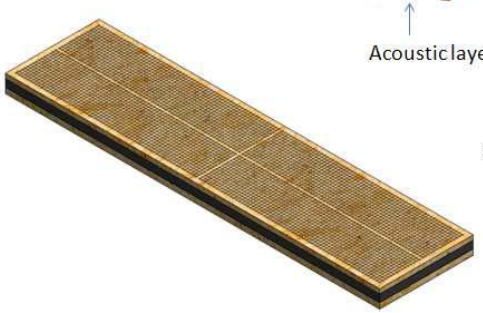
WoodRub ACOUSAN: Acoustic panel and works wall

Material:

- Recycled particleboard (external layers)
- Rubber particles + PU resin (absorbent layer)







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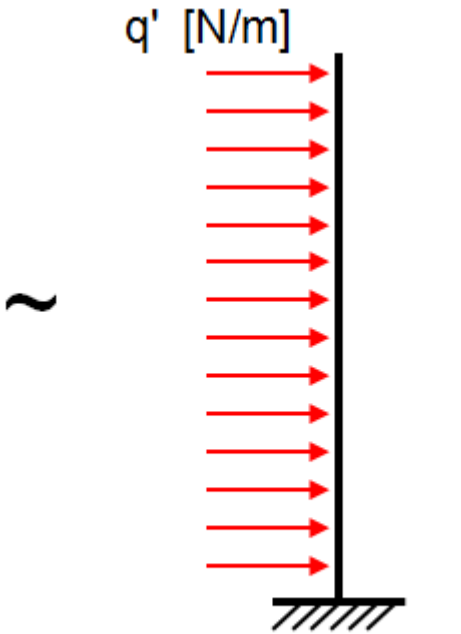
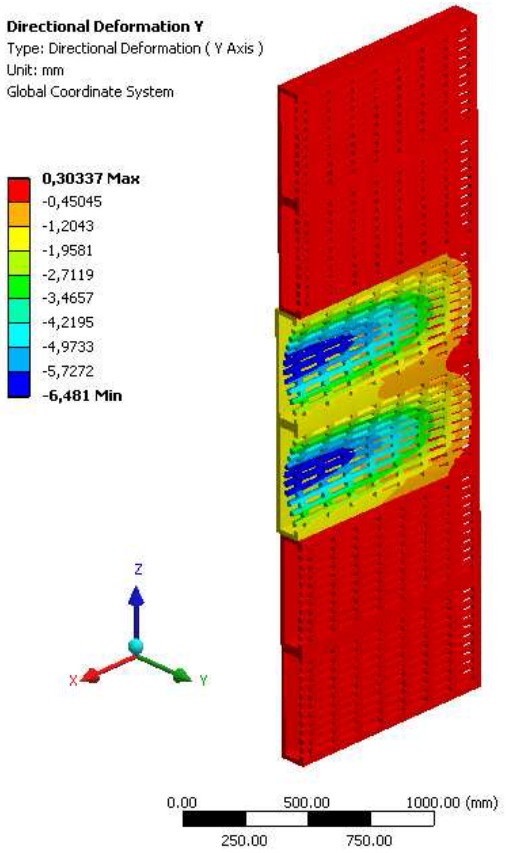
Testing of WoodRub prototypes

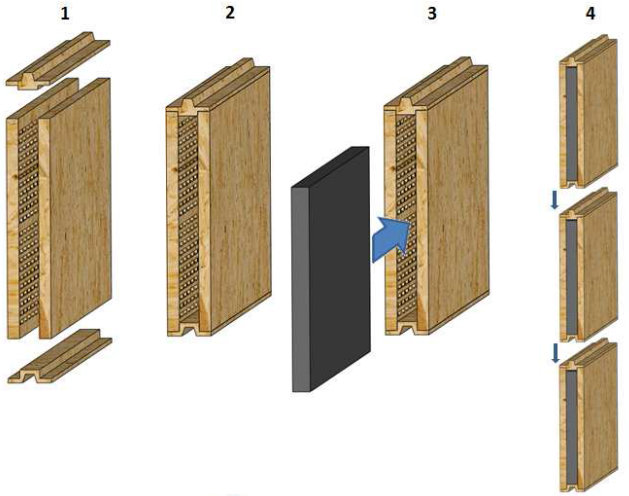
- EN standards
- Acoustic
- Thermal
- Mechanical
- Durability
- VOCs emissions
- Stability

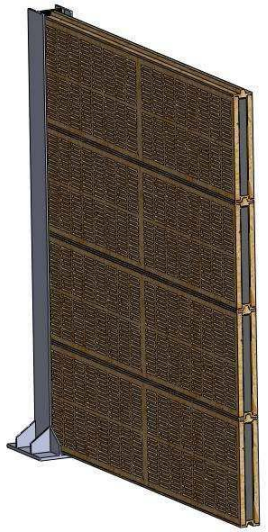




Advantages of WoodRub prototypes

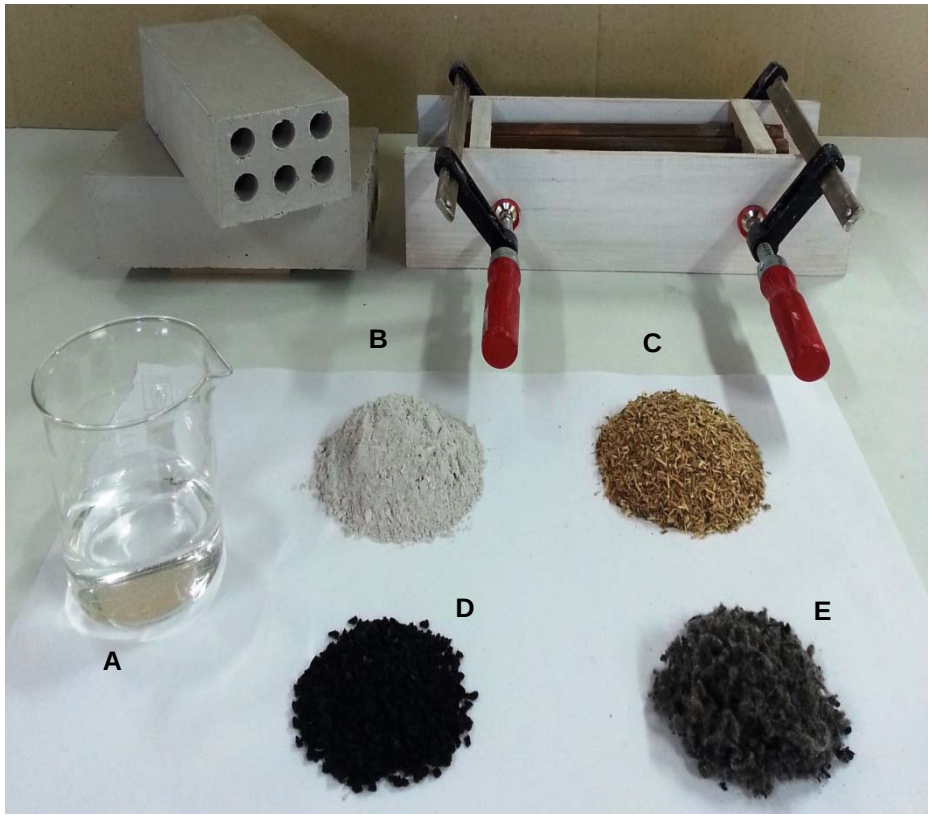
- Great environment integration
- Good aesthetic possibilities
- Durability behaviour
- Economical materials
- Versatile
- Easy maintenance
- Simple production lines





Gypsum-based bricks (WoodRub BRICKS) manufactured from recovered wood and rubber

Manufacturing process of WoodRub Bricks



Raw materials:

Water (A), gypsum (B), recovered wood 1-2 mm (C) and rubber 2-4 mm fractions (D), and reinforcement material-reduced rubber material containing textiles (E)

Manufacturing process of WoodRub Bricks

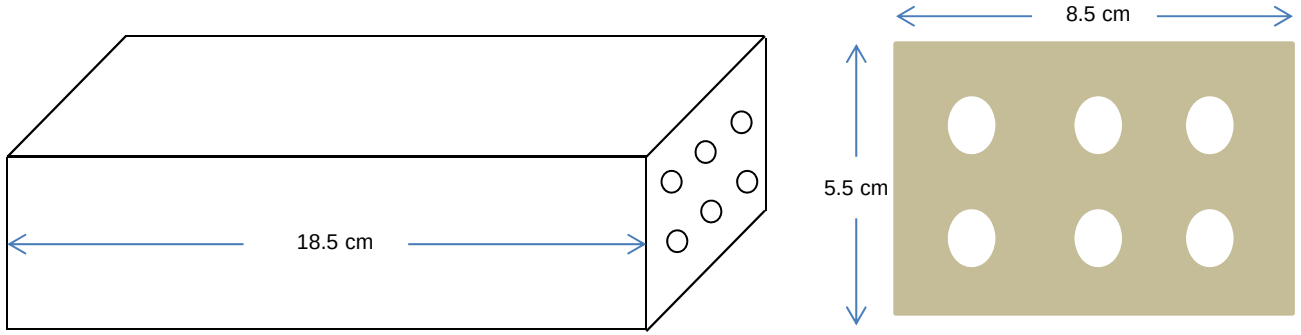
Mixing of materials

All materials were fully mixed up in a 1:1.5 gypsum-water solution in proportions per weight:

- 70 % gypsum-water solution
- 15% wood chips
- 10% rubber particles
- 5% rubber-textile

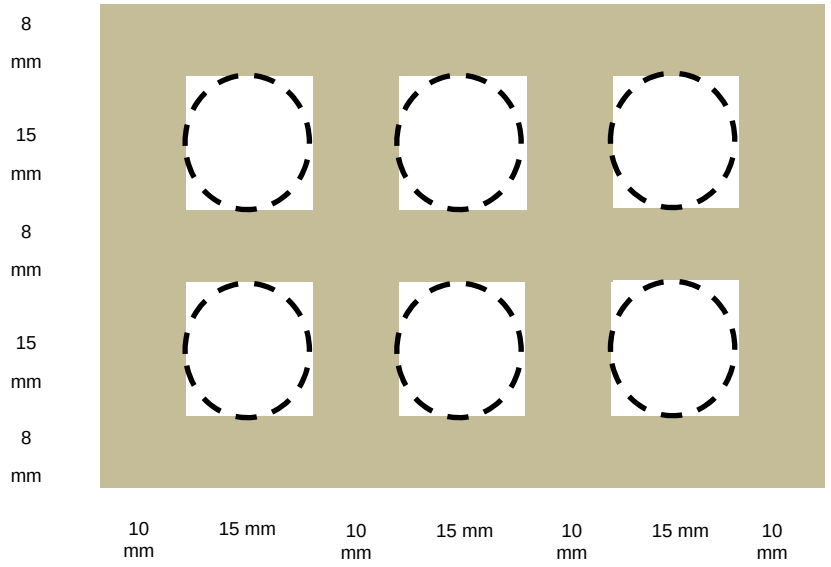
Rectangular moulds with the selected brick standard dimensions of 8.5 × 5.5 × 18.5 cm

Manufacturing process of WoodRub Bricks

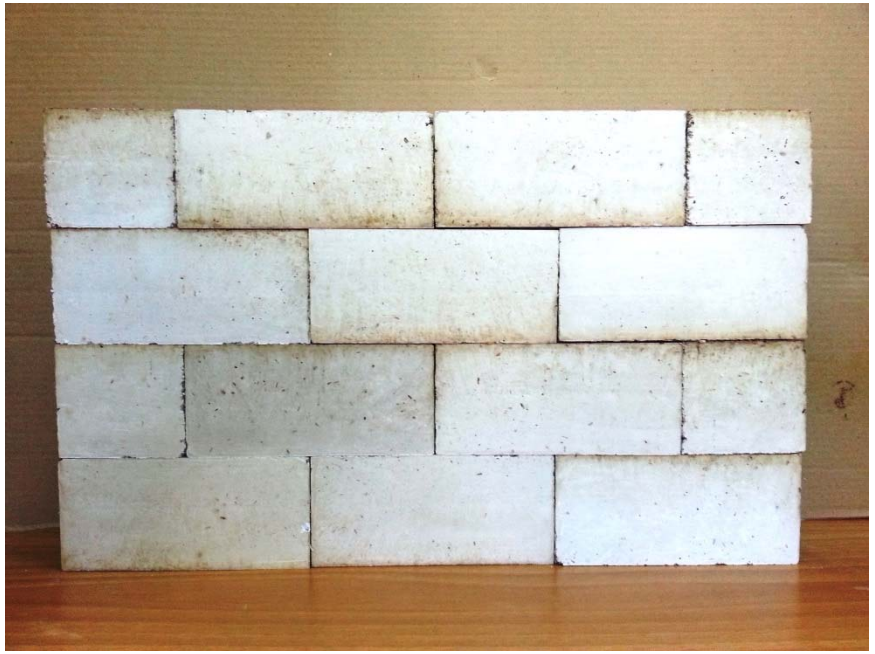


Design

Full size WoodRub brick (up left), front side with 6 symmetric holes (up right), dimensions of the front side with the holes in detail (down)



Manufacturing process of WoodRub Bricks



Drying and final application (internal walls)

- Air-drying in ambient conditions for 1 week
- For shorter drying periods, in an oven at low temperatures of 30-35^{o}C

Testing of WoodRub bricks

Density

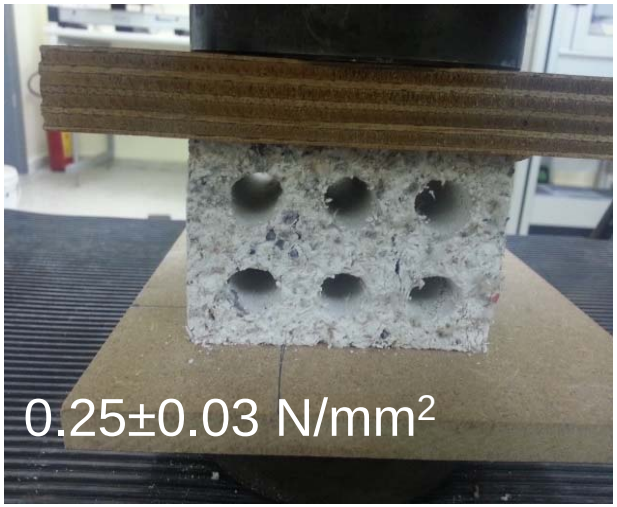
- Density of 20 orthogonal WoodRub bricks: 0.58±0.02 g/cm^3
- Method: weighting and calculating the volume
- Stable void volume of every brick: 196.05 cm^3 (holes represent 22.76% of the brick volume)
- Density of the wood/rubber material used: 0.75±0.03 g/cm^3

Testing of WoodRub bricks

Compression strength

- SHIMATZU Testing machine, ASTM C39/C39M-12a (1983) standards
- Three directions of bricks by different loading:
  - Lateral upper side at the large surface 8.5 × 8.5 cm (down right)
  - Lateral upper side at the small surface 5.5 × 8.5 cm (down left)
  - Axial at the surface 5.5 × 8.5 cm (up right)

Testing of WoodRub bricks



Compression strength

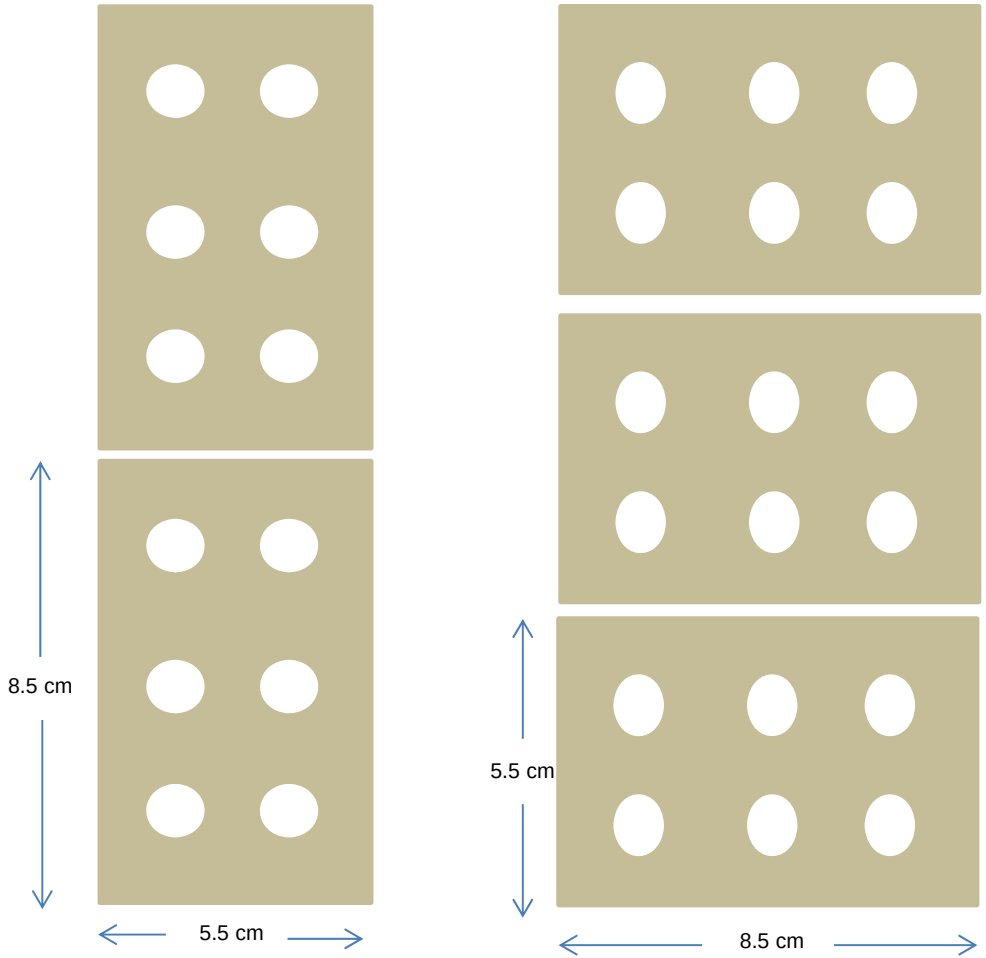
- Bricks performed slightly better when loaded at the large surface of the lateral upper side than at the small surface
- Failures occurred towards the direction of load in the material under a hole or between the rows of holes

Testing of WoodRub bricks

Compression strength

- Strength almost double in the axial direction, mean value 0.48±0.20 N/mm^2
- Diverse failures (3 groups)
- Bricks with mode of failure as in the first left photo: almost double strength than the other two modes

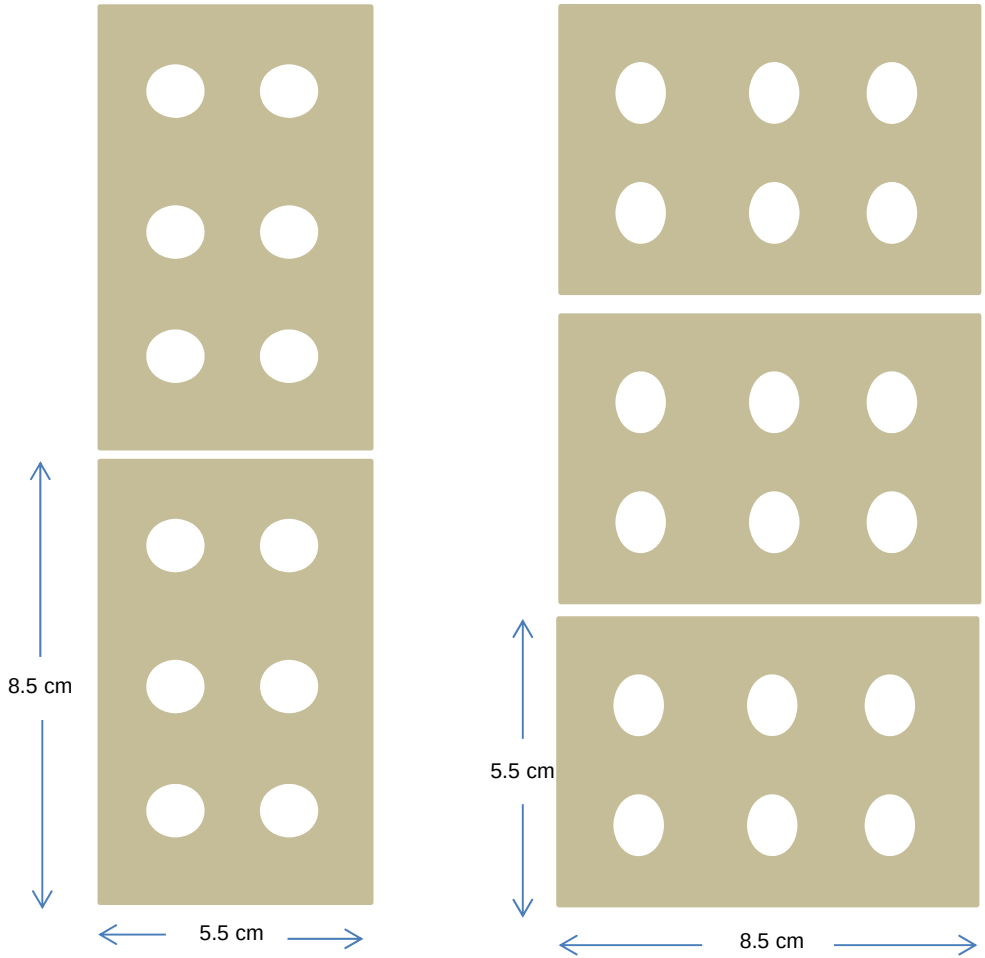
Static calculations for internal walls



<u>3 m wall with the bricks put with their small surface (left)</u>

- Requires 35 bricks for a single row from the floor to the top
- Each brick is able to bear around 2,074 N or 211.49 Kg
- More than enough as the 35 bricks weight around 17.5 Kg (the weight of one brick is around 0.5 Kg)

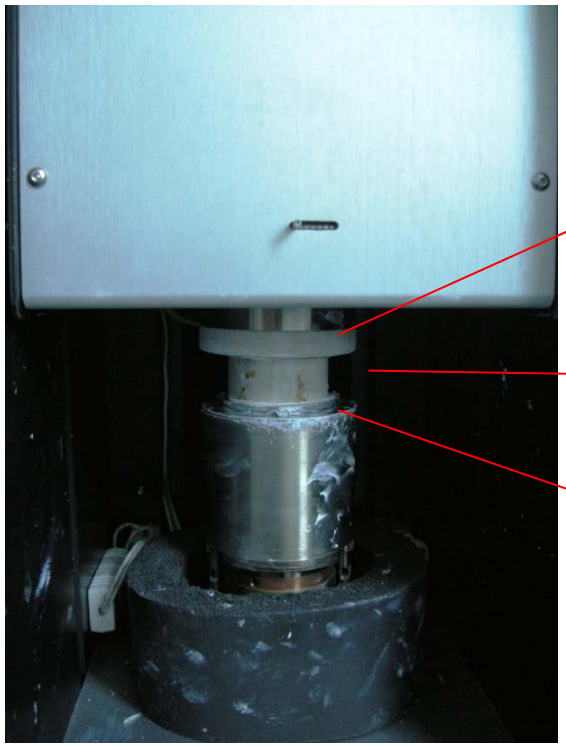
Static calculations for internal walls



<u>3 m wall with the bricks put with their large surface (right)</u>

- Requires 55 bricks for a single row from the floor to the top
- Each brick is able to bear around 3,622 N or 369.34 Kg
- More than enough as the 55 bricks weight around 27.5 Kg (the weight of one brick is around 0.5 Kg.

Testing of gypsum products



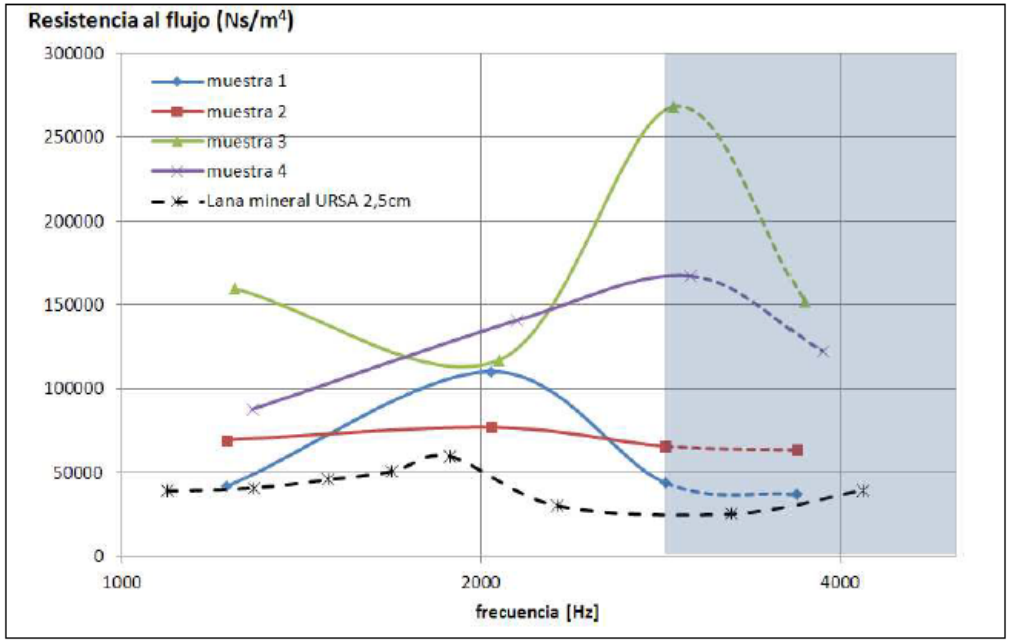
Thermal conductivity

- Anter Unitherm™ Model 2022, guarded heat flow meter method, ASTM E1530 Standard
- The thermal conductivity coefficient (k) of WoodRub bricks: 0.274 W/mK
- Better thermal insulation than both the extruded and pressed house bricks with a thermal conductivity coefficient of 0.33-98 and 0.87-1.10 W/mK, respectively
- The insulating bricks perform much better (thermal conductivity coefficient of 0.15 W/mK)

Testing of gypsum products

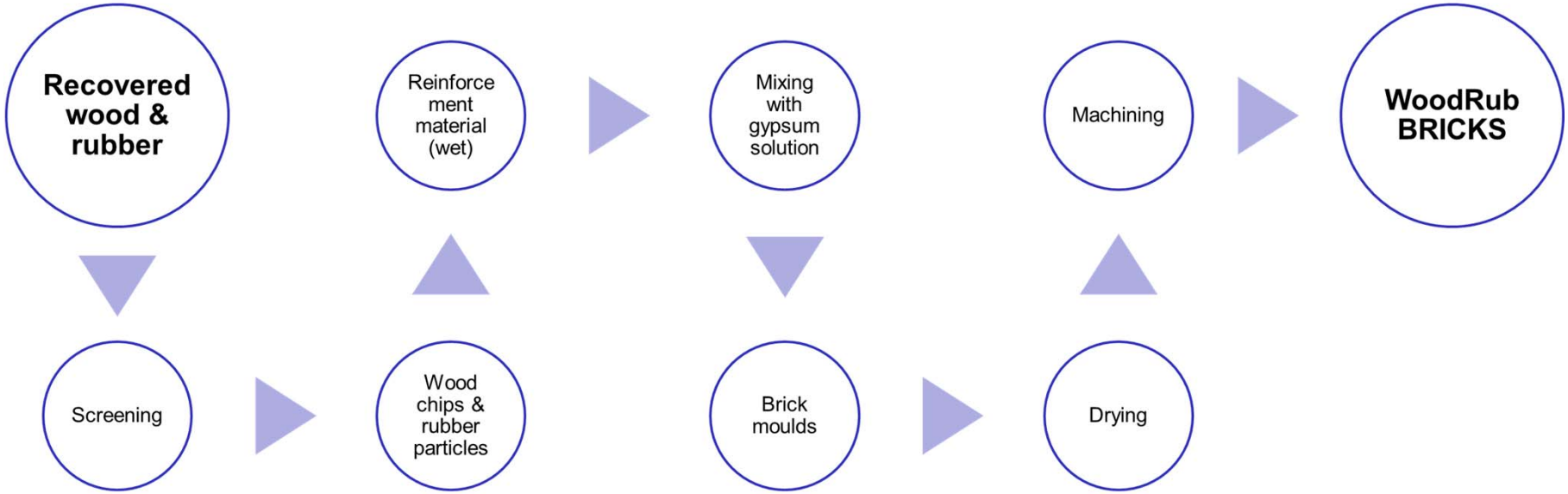
Acoustic insulation

- Impedance tube method according to ISO 10534-1 standard
- Samples 45 mm in diameter, 30 mm height
- Sound absorption coefficients at 1KHz = 0.72, 2KHz = 0.43, 3KHz = 0.45
- Low porosity of samples, variable results/ heterogeneous samples



Production line for WoodRub bricks

Theoretical scheme of a manufacturing line for WoodRub bricks (extruded)



Thank you