POLITECHNIKA LUBELSKA
LUBLIN UNIVERSITY OF TECHNOLOGY

TB Ekspertyzy i Projekty Budowlane

Multi-layer insulating wall block

Bio-based insulation with hemp shives, magnesium binder and phase-change material

PATENT B1 246388

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Author of the presentation: Przemysław Brzyski, Dr. Eng.

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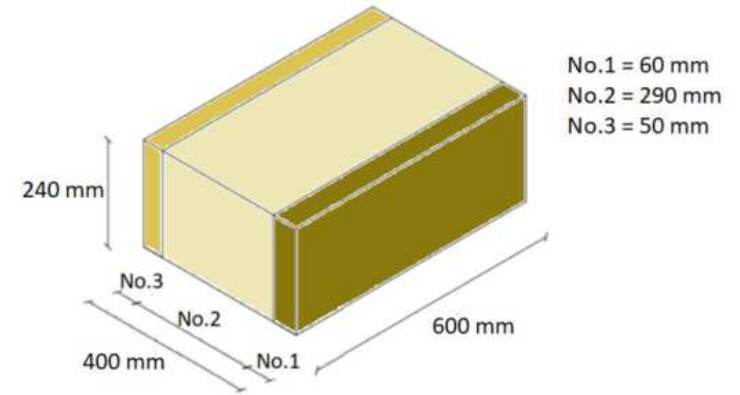
Invention at a glance

A modular block designed for frame walls and high-performance thermal envelopes



Thermal target

Wall thickness supports U<0.2 W/(m²K).

Heat storage

PCM layer improves thermal stability and indoor comfort.

Proof stage

Test house and laboratory validation demonstrate feasibility.

Core idea

Insulating wall filler based on hemp shives and magnesium binder.

Inventors: Przemysław Brzyski, Tomasz Bujnowski, Łukasz Cieślikiewicz, Piotr Łapka

Patent application A1 446906
Patent granted in 2025

From mixture to ready block

A simple manufacturing path suitable for scaled demonstration

1 **Mixing**

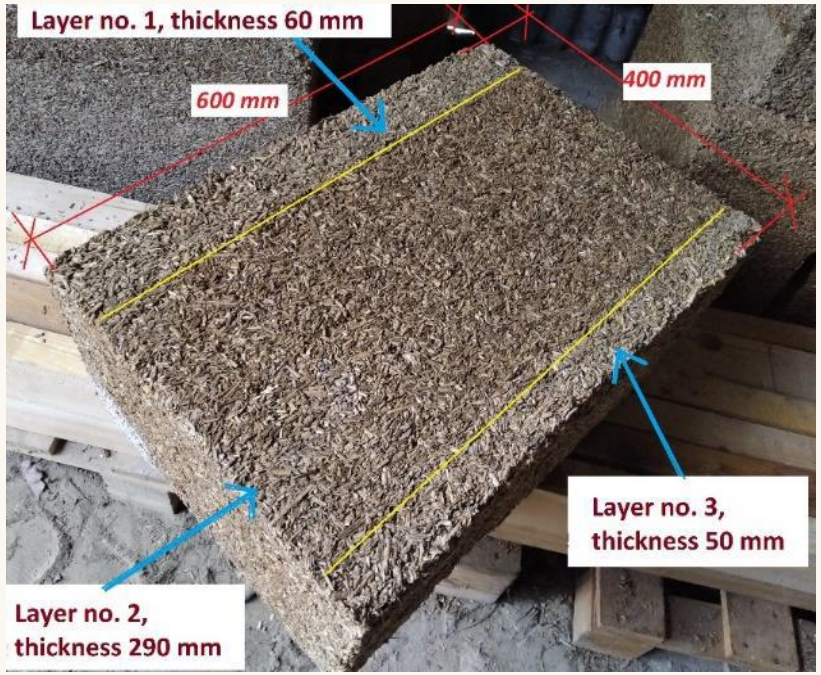
2 **Forming**

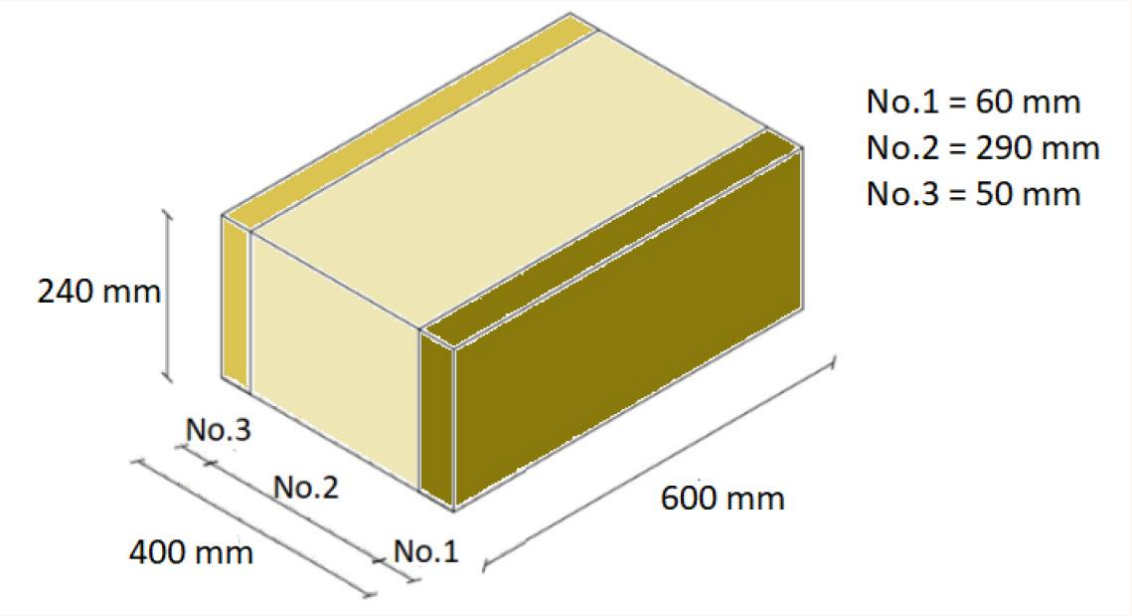
3 **Seasoning**

Process message: local bio-aggregate + mineral binder + layered compaction = durable insulation with a clear production logic.

Three-layer architecture

Density is tailored by function: strength outside, insulation inside, PCM for thermal stability





Outer layers (No.1, 3)

Approx. 400 kg/m³ for mechanical protection and surface integrity.

Middle layer (No.2)

Approx. 220 kg/m³ to reduce thermal conductivity.

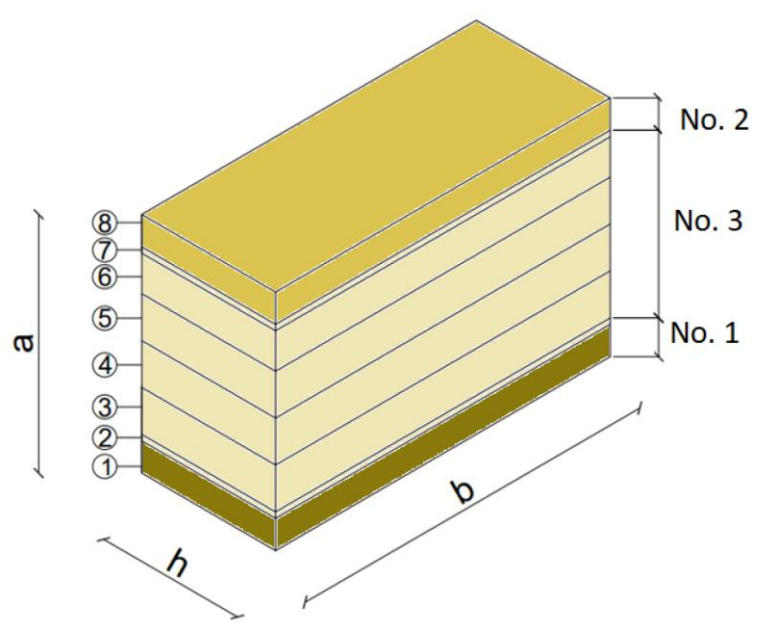
PCM layer (No.1)

Inner layer contains phase-change material for heat-buffering.

Nominal block dimensions: 400 x 600 x 240 mm – the thickness of the wall is 400 mm

Designed heat-flow direction

Layered placement and perpendicular compaction help arrange shives advantageously



a=400 mm, b=600 mm, h=240 mm

Layering control

Mixture is laid in approximately **50-70 mm** layers for a uniform structure.

Fiber orientation

Compaction direction is perpendicular to the **240 x 600 mm** surface.

Thermal benefit

The resulting **shive orientation** supports lower thermal conductivity.

Semi-realistic demonstration

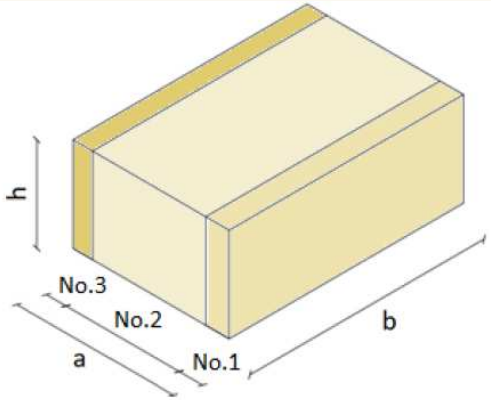
A test house validates the wall system beyond individual laboratory samples

Test house: 2.6 m x 3.1 m | 400 mm wall | insulating mortar | lime plaster outside | clay plaster inside

REAL-WORLD WALL ASSEMBLY

Laboratory validation

Mechanical, density and thermal parameters tested by layer



No.1 - internal (60 mm), with PCM
No.2 - middle (290 mm)
No.3 - external (50 mm)

Parameter	Type of the composite		
	Internal layer (No.1)	Middle layer (No.2)	External layer (No.3)
Apparent density (kg/m^3)	434	217	452
Total porosity(%)	77.6	88.1	77.3
Thermal conductivity (W/(mK)	0.103	0.069	0.112
Compressive strength (MPa)	1.41	0.22	1.48
Flexural strength (MPa)	0.43	0.07	0.5

Strong outer shell

External layers exceed strength of comparable lime-based materials.

Insulating core

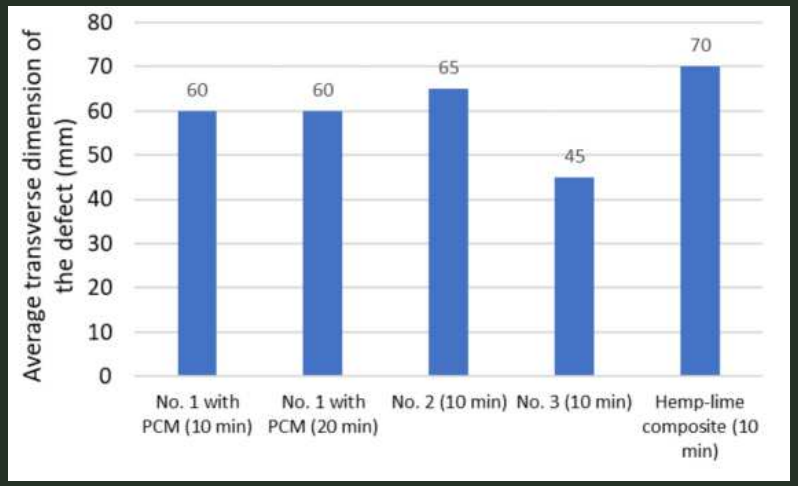
Middle layer keeps low density while maintaining stiffness.

MgO advantage

Magnesium binder differentiates performance from lime composites.

Ignition resistance

When exposed to flame, only the directly heated surface area chars



Key observation

The material is resistant to ignition; char formation remains localized under direct flame exposure.

Why this invention matters

A bio-based wall block designed for insulation, durability and thermal comfort

Energy performance

Insulating wall thickness supports U-value below 0.2 W/(m²K).
Compaction aligned with heat flow improves insulation and reduces thermal conductivity.

Strength performance

Outer layers show quite high strength, outperforming similar lime-based materials. The low-density middle layer provides stiffness and low thermal conductivity, outperforming lime-based composites.

Thermal comfort

PCM integration increases heat storage and smooths temperature swings.

Sustainable material logic

Hemp shives reduce reliance on conventional mineral insulation fillers.

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Thank you

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