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# LEHMBAU

## A BIOREGIONAL MATERIAL: FROM RESILIENT FORESTS TO REGENERATIVE LANDSCAPES AND FIRE RESISTANT HOMES

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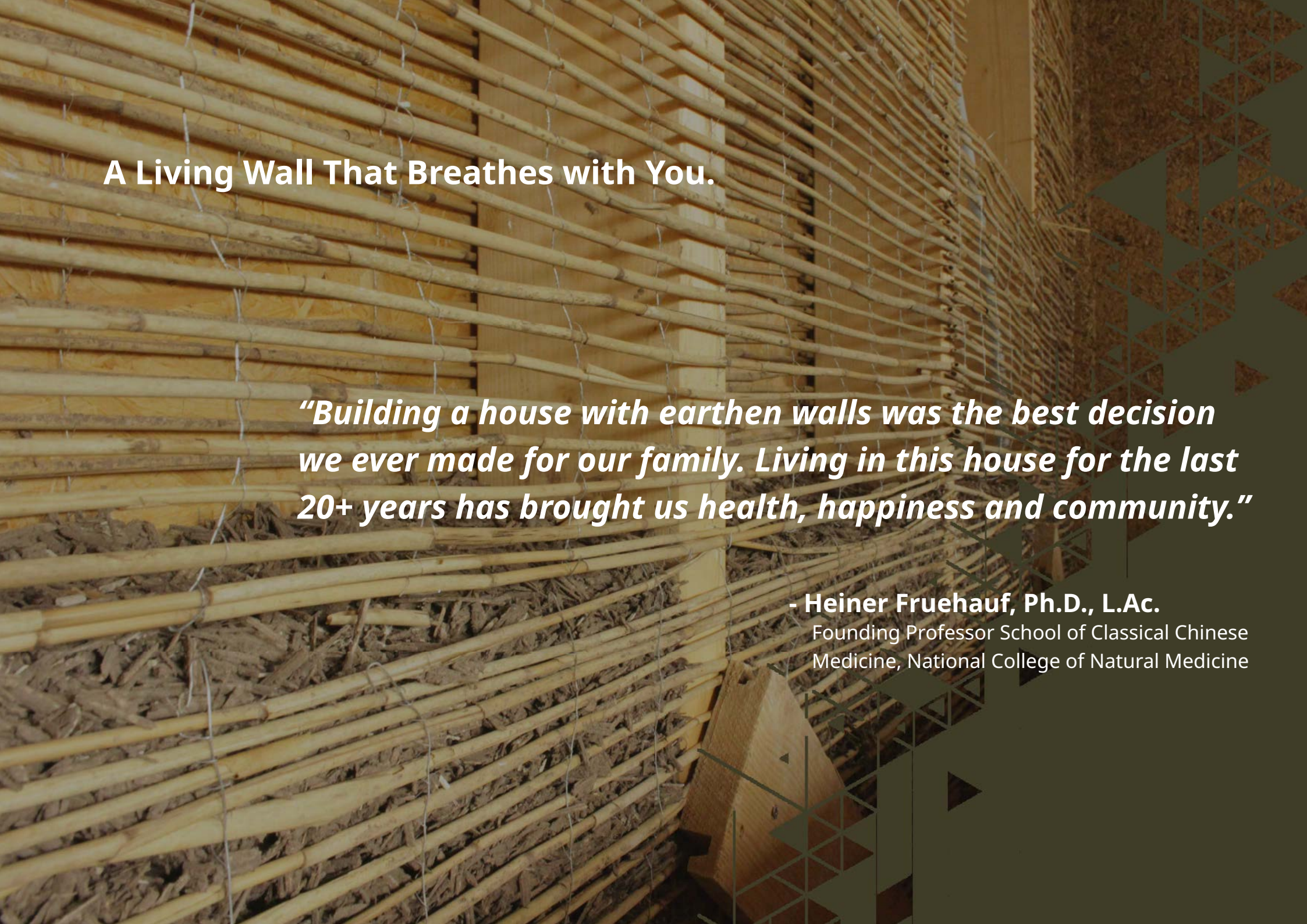
# From Forest to Home:
## Creating Safe and Regenerative Architecture with Nature

**Lehmbau, clay-and-fiber construction, is an age-old material that fits today's needs: hyperlocal sourcing, climate friendliness, healthy indoor climates, and support for biodiversity.**

As a biogenic assembly, it locks carbon in natural fibers such as wood chips, hemp, and straw. Clay encases and preserves these fibers, regulates moisture, and contributes to fire-resistant structures. The result is a climate-smart approach that shifts from emitting carbon to storing it and helps shape healthier, wildfire-resilient neighborhoods.

*This brochure and infographics are a collaboration between **Autopoiesis** and **Except Integrated Sustainability**, two organizations applying systems thinking to develop solutions for a regenerative, just and sustainable society.*

Version 1.0



## A Living Wall That Breathes with You.

*“Building a house with earthen walls was the best decision we ever made for our family. Living in this house for the last 20+ years has brought us health, happiness and community.”*

**- Heiner Fruehauf, Ph.D., L.Ac.**
Founding Professor School of Classical Chinese Medicine, National College of Natural Medicine

Fruehauf House

Fruehauf House, Corbett

Interior with Lehmbau walls

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# A Healthy Third Skin
## with Lehmbau walls

**The Fruehauf House and Hai Shan Clinic**
**2004 Corbett, Oregon**
The design of this home and clinic features health, renewable biobased regional materials, sacred geometry and harmony with the Earth element in Chinese Medicine. An enduring lehambau clay + woodchip walled shelter, the warmth and sense of being is palpable. Standing in the main room, as you exhale, your body relaxes and you can hear your heart pumping. You are comforted and calm held by these lehmbau walls.

On site ecological forestry thinnings are used in the wood lath and wood chip walls. Combined with a clay slip made with onsite clay, lehmbau is a fire resistant breathable wall that is affordable and replicable. Rye grass panels were compressed by a local farmer for interior wall clay plaster (2nd floor) and reed mats provided the lath for interior partition walls.
A highly collaborative effort, this home has welcomed Chinese medicine student retreats, green building tours, weddings, and ceremonies. The clinic is frequented by visitors from all over the world.

**True Nature Radio:**
Building in Harmony with Nature

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## A home that bonds to living systems.

***“When we design with living systems there is a beauty, harmony and relationality with nature and spirit that transforms us. 'Mater' in Latin, is mother. Clay connects us to materiality in a profound way. The mother is sacred. Growing and making buildings with natural materials supports healthy ecosystems and enlivens our sense of well being.”***

**- Kathryn Langstaff**
Founder Autopoiesis, LLC

Benefits of Lehmbau

# Harmonious Living through Nature-Based Design

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Nature designs through relationships, harmony is not built, but grown. Lehmbau follows this living logic, where earth, fiber, and craft work together to create walls that breathe, adapt, and endure.

## Enhances Biodiversity
Supports regenerative landscapes and restores natural habitats through local biomass and soil-based construction.

## Supports Wildfire Prevention
Revenue from Lehmbau materials can support wildfire prevention efforts.

## Green Job
Promotes job creation in sustainable construction and ecoforestry.

## Upcycling
Uses local biomass waste (woodchips, grain, grass) to reduce waste and create economic value.

BIOCIRCULAR ECONOMY

## Charred Surface Layer
Lehmbau walls form protective surface char layers and reduce flame spread.

## Natural Fire Resistance
Woodchips, hemp, and straw coated in clay are naturally fire-resistant.

## Reduces Oxygen and Flame
Compressed Lehmbau material in slip form decreases oxygen levels and slows flame spread.

FIRE RESISTANT

# LEHMBAU
# FIBER AND CLAY

## Carbon Sequestration
Lehmbau can sequester carbon for up to 60 years, improving environmental impact.

## Thermal Mass for Heat Storage
Lehmbau stores heat, enhancing thermal regulation.

## Transport Cost Savings
Lower transport costs due to the use of locally sourced materials.

## Carbon Reduction
Lehmbau has low carbon emissions and energy consumption, reducing $CO_2$ footprint.

ENERGY, MATERIAL & CARBON

INDOOR CLIMATE

## Reduces Electromagnetic Fields
Lehmbau helps mitigate the effects of electromagnetic fields.

## Healthy Indoor Air Quality
Vapor-permeable walls promote healthy air circulation indoors.

## Sound Barrier and Calming Effect
Acts as a sound barrier, creating a calm and peaceful environment.

## Inhibits Mold Growth
Prevents the growth of hazardous molds, improving indoor air quality.

## Toxin Sequestration
Lehmbau absorbs and traps harmful toxins in the air.

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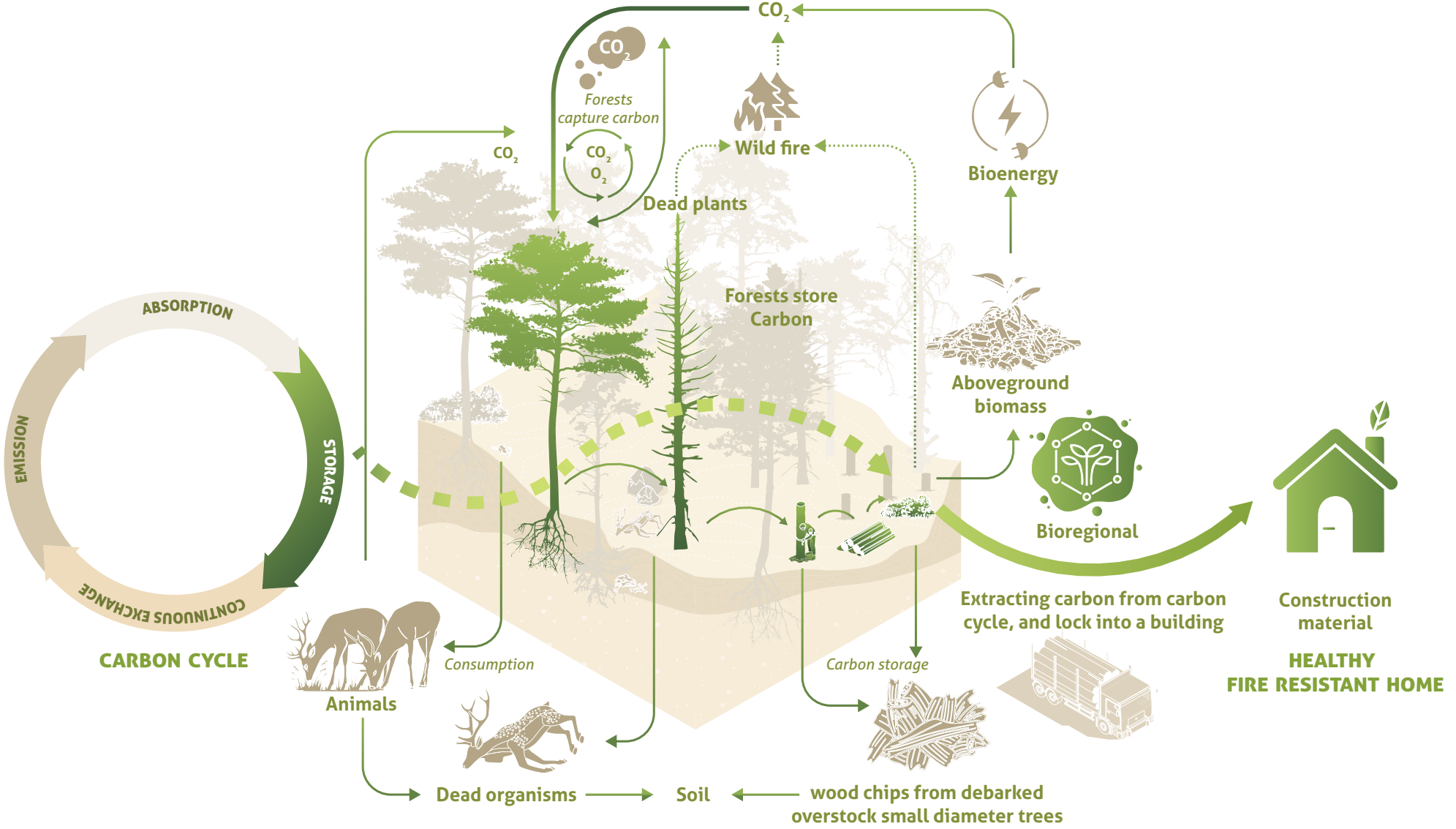
## Regenerative landscapes enhance biodiversity.

*Ecotrust Forest Management (EFM) acquired the 3,243 Sooes forest on the Olympic Peninsula in Washington State in 2006. The forest is managed using a climate-smart and ecosystem-based forestry approach that prioritizes long-term forest health, carbon storage, habitat protection, and responsible timber harvesting. A key part of EFM's philosophy is transitioning managed forests to permanent conservation-oriented owners, such as Tribes or land trusts. Autopoiesis partners helped with the $50 million Federal New Market Tax Credit award.*

# Locking Carbon into Safe, Regenerative Architecture

Regenerative forestry sequesters carbon and yields an abundance of natural fibers that become the foundation of regenerative architecture.




**A FOREST STORES CARBON INTO BIOGENIC MATERIAL**

# A NATURAL BUILDING METHOD TO MEET REGIONAL CLIMATE GOALS

*The 2024 International Residential Code (IRC) covers a particular type of Lehmbau known as light straw-clay construction.*
*The advantages of light straw-clay described in Appendix BI include thermal performance and environmental impact.*

*IRC 2024 Appendix BI Light Straw-Clay Construction*
*This appendix governs the use of light straw-clay as a non-bearing building material and wall infill in Seismic Design Categories A and B. Use of light-straw clay in Seismic Design Categories C, D0, D1, and D2, requires an approved engineered design by a registered professional in accordance with Section R301.1.3.*

# Local Materials Provided by Living Systems

Each part of a Lehmbau home is born from the place where it grows. Clay, wood, and local wisdom come together in harmony. Every wall, ceiling, and joint a dialogue with the living systems, a piece made for the others.

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## Overview of application

1. **Ceiling insulation (between beams)**
   - Lightweight mixtures of clay and plant fibers (e.g., hemp, straw)
   - Natural fire and sound insulation
2. **Interior walls and partitions**
   - Excellent thermal mass and humidity regulation
   - Sound-absorbing and healthy for indoor air quality
3. **Infill walls**
   - Non-load-bearing walls in timber frames or cross laminated timber
   - Often used with light straw clay or woodchip clay mixtures
4. **Floor insulation and subfloor fill**
   - Clay and fiber mixes can be used under natural flooring
   - Passive design - Adds thermal mass and regulates moisture and humidity
5. **Exterior walls with lime or clay plaster**
   - Fire-resistant, breathable, and durable
   - Applied with natural finishes for weather protection
6. **Wooden Columns**
   - Made from wood harvested through ecological forestry

*Rye glass panels*

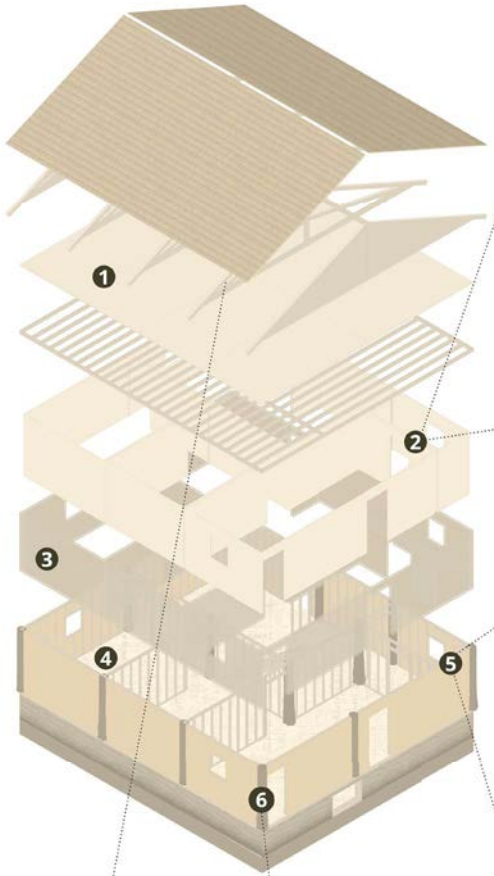
*Test lehmbau mixture*

*Sheathing wooden frame*

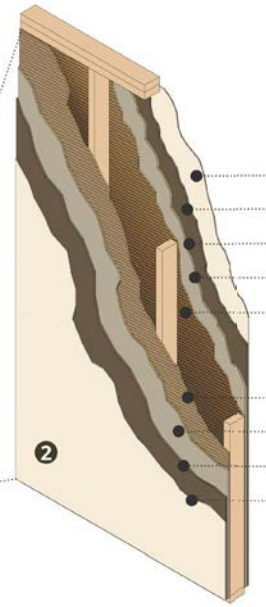
*Interior finish plaster*

*Clay based earth plaster base/scratch coat*

*Reed mat*

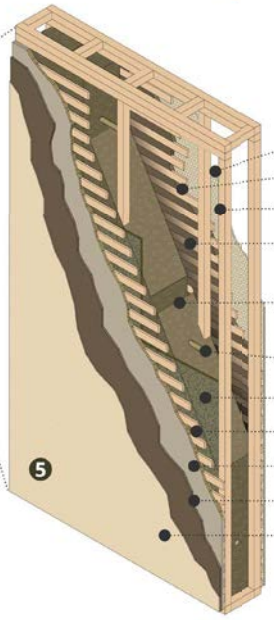



*Wood structure*



**Interior wall structure**

*Finish clay/mineral plaster*
*Clay based earth plaster brown coat*
*Clay based earth plaster base/scratch coat*
*Reed mat staple with baling wire to studs*
*Stud wall Advanced framing*
*Reed mat*
*Clay based earth plaster base/scratch coat*
*Clay based earth plaster brown coat*
*Finish clay/mineral plaster*



**Exterior wall structure**

*Finish clay/mineral plaster*
*Clay based earth plaster brown*
*Clay based earth plaster base/scratch coat*
*Lath sheathing wooden frame or rush board or res*
*Lehmbau: woodchip clay infill (compress every thr*
*and place a bamboo horizontal tie in hole in stud*
*Stud wall: Advanced framing, studs alternate 24" stagger exterior and interior walls*
*Rye glass panels: rainscreen, insulation*
*Lath*
*Clay based earth plaster base/scratch*
*Clay based earth plaster brown coat*
*Lime plaster/ mineral paint exterior finish*

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# From Small Pieces, a Home Grows

From earth and fiber to family hands, walls take shape and a home emerges. Each step draws nature closer inside, bringing warmth, connection, and a deep sense of belonging.

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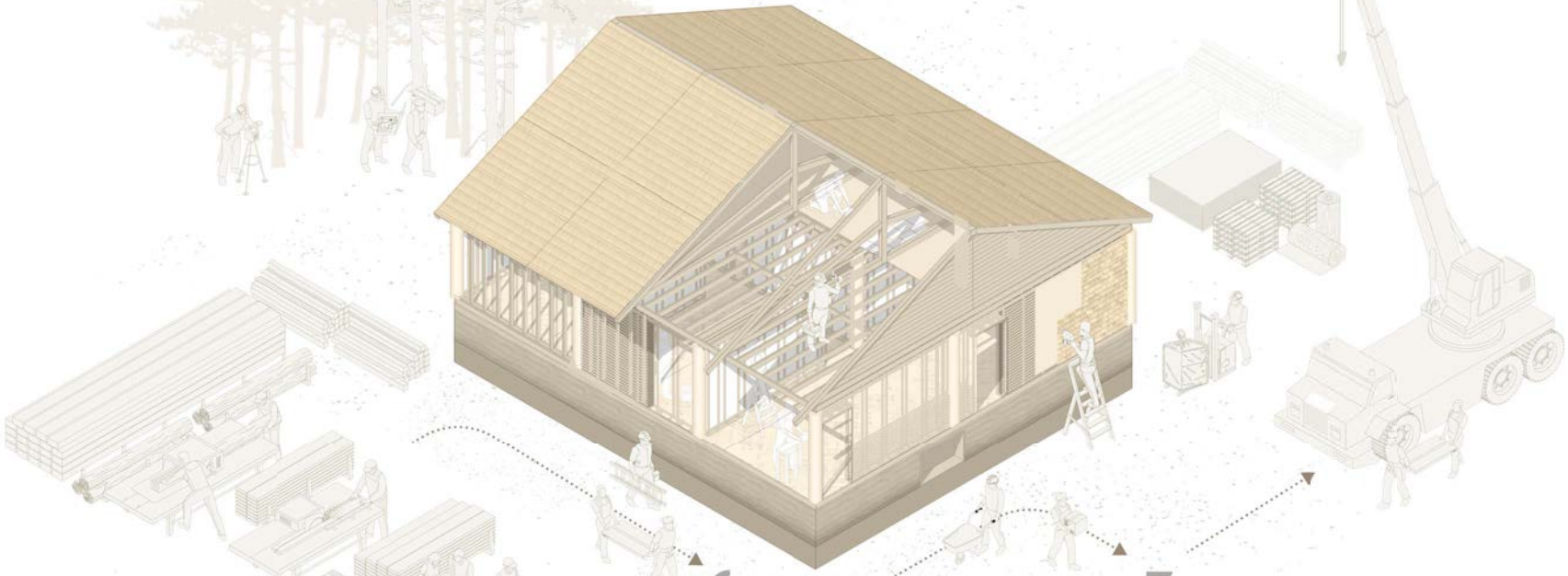

**1 Sifting Clay**
The local clay is sifted through a 1/4" mesh screen to remove stones and impurities. When harvesting clay, remove the topsoil, then if possible, expose to sun, wind and rain to let it naturally sift.

**2 Making the Slip**
Test the clay to determine the ration of clay slip to fiber: woodchip, hemp, straw. Fine clay is mixed with water in a suitable ratio using a mortar mixer to create a slurry.

**3 Mixing with Wood Chips**
The slurry is mixed with wood chips using a concrete mixer at a specified ratio. To determine the correct proportion of clay slurry:wood chips, tests should be conducted on density and R-value. The wood chips must be bark-free and approximately 1 1/4 inches in size.

**4 Making a Test Wall**
Test in a short framed wall with framing lumber to simulate the final woodchip and clay application. The material's binding properties and lightness are tested. The density should be < 600kg/m³. A plaster layer is also tested in this stage.

**5 Timber Frame**
Construct the main timber frame (post & beam) using wood products from sustainably managed forests, or harvest on-site when possible

**6 Wall System**
Build the 12" wide vertical frame with 2x6 studs alternating 24" on the interior and exterior sides of the wall to eliminate thermal bridging. Cover with 1/2" x 1" wood lath to hold the woodchip clay mixture. Lath also helps achieve wall shear.

**7 Wall Construction**
The woodchip clay mixture is placed into wall cavities using wheelbarrows or conveyors, with wood lath installed as the wall is built from bottom to top. The 12 inch thick wall dries at a rate of 1 week per inch, with an insulation value of R-22.4 (≈ R-2.0 per inch). The framed wall width is adjusted to meet local code requirements.

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# Reduce Our Footprint, Build for the Planet

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Several steps in the Lehmbau construction avoid $CO_2$ emissions, lock biogenic carbon, and save energy compared with conventional timber framed as well as brick and concrete construction.
Scaling clay-and-fiber construction across the built environment turns housing into a catalyst for change.

## 1 Sifting Clay

No cement or fired bricks

## 2 Making the Slip

Water and relatively little energy used compared to cement mixing

## 3 Mixing with Wood Chips

**Action:** Wood fiber, straw, and chips are added to create the bio-based wall mix.
**Carbon Note:** Stores biogenic carbon that would otherwise re-enter the atmosphere through burning or decay.

## 4 Making a Test Wall

**Action:** The mixture is tested for density, moisture, and long-term durability.
**Carbon Note:** Confirms stability of stored biogenic carbon in the final wall assembly.

## 5 Timber Frame

**Action:** The frame is constructed using straightforward tools and skill sets.
**Carbon Note:** Timber stores carbon absorbed during tree growth and replaces more carbon-intensive materials (brick, steel, concrete in global markets).

## 6 Wall System

**Action:** Wall frames are set up and filled with the woodchip–clay mixture.
**Carbon Note:** Major contributor to total carbon storage through bio-based infill.

## 7 Wall Construction

**Action:** Walls are closed and finished using earth and fiber materials.
**Carbon Note:** Represents the total stored carbon in timber + chips + straw + clay system.

**Lehmbau House = 40 t $CO_2$e stored & avoided***
**Equivalent to ~2,000 trees/year**

**Based on figures from RMI's Building with Biomass (2025), comparing a bio-based wall and finish system (straw, clay, cellulose, wood fiber) to a typical U.S. single-family home using conventional materials such as timber frame, fiberglass insulation, gypsum board, OSB, and fiber-cement cladding.*

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# Image credits

## Photos

Exterior Freuhauf house, Portland
*by Sally Painter Photo*

Interior Freuhauf house, Portland
*by Sally Painter Photo*

Interior Freuhauf house, Portland
*by Sally Painter Photo*

ADU, Placecraft, Willamette Valley, Oregon
*by Olivia Ashton*

Sunbeams in the forest
*by Ron O, Unsplash*

## Infographics


Diagram Harmonious Living through Nature-Based Design
*by Except Integrated Sustainability*

Diagram Locking Carbon into Safe, Regenerative Architecture
*by Except Integrated Sustainability*


Diagram Local Materials Provided by Living Systems
*by Except Integrated Sustainability*

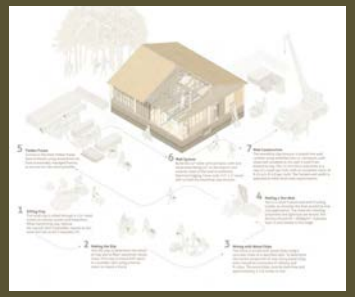

Diagram From Small Pieces, a Home Grows
*by Except Integrated Sustainability*

Diagram Reduce Our Footprint, Build for the Planet
*by Except Integrated Sustainability*

# Colophon

***Autopoiesis is a climate smart design firm. We engage with self-organizing living processes at building, site, landscape and organizational levels to support wholeness and regeneration.***

Among our wide-ranging ecological projects, our holistic approach supports eco-forestry with partners like Ecotrust Forestry Management, the Karuk tribe, and small ecoforesters for 30 years in forest to home projects that enhance biodiversity and foster health and wellbeing.

***Except Integrated Sustainability is a strategy and concept studio for systemic impact, working across the built environment and guiding organizations toward a sustainable society.***

*For 25 years we have crafted the world of tomorrow: regenerative, healthy, and just. Together with partners, we shape business strategy, urban landscapes, and industries into sustainable, circular, and resilient ecosystems.*


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