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VOUS FAITES LE BON CHOIX

Pisé
and energey renovation

CONSEILS GRATUITS
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Introduction

Pisé is a construction technique using raw earth that has been used for centuries.
This type of construction, with its heritage identity, requires special attention and know-how when it comes to renovation. This document provides some ideas for renovation work on old pisé buildings.

Caracteristics of Pisé

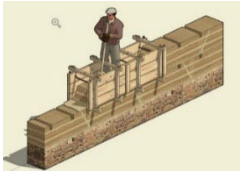
Physical properties of the material

In addition to its availability, **soil has many qualities**:

- **Humidity regulator**
  Soil can absorb water vapor when there's too much in the indoor air and release it when there's not enough.
- **Phase change of water in the earth's pores**
  Evaporation and condensation of water in the wall. These thermodynamic transformations consume and produce heat. They help warm the wall in winter and cool it in summer. (This phenomenon impacts the properties of conductivity, specific heat and resistance to water vapor. NOTE: these aspects are not taken into account in thermal modelling)
- **Phase-shifting thanks to high intertia**
  Acts as a shock absorber for temperature variations (providing good summer comfort).
  Good ability to store heat and radiate it back.
- **Sound insultation and acoustic quality**
- **Easy to rework** but requires know-how.
- **Lifetime**: century-old buildings are very common in the region.
- **Low environmental impact**
  Locally available material, little energy required for manufacture, no waste when the building is deconstructed. Can be reused indefinitely (unless mixed with lime or cement to stabilize it)

Thermal Conductivity (λ) : W/m.K	Water vapour diffusion resistance coefficient (μ)	Specific heat cp:J/kg-K	Thermal phase shift h	Fire resistance (class in accordance with NF EN 13501-1)
0,5 to 1,1	5 to 11	830	10 to 12 hours for a 50 cm wall	A2 (non-combustible)
Ability to transmit heat. The smaller λ, the more insulating the material is.	*The higher μ, the higher the resistance to water vapour diffusion is.*	*Ability to store heat.*		

Designing and installing pisé



Architecture
Traditionally, pisé buildings wear « **good boots** » and a « **good hat** ». In other words, the base is built to **limit capillary rise from the ground** (usually in cobblestones, hard stones with low porosity or masonry clay bricks) and the roof overhang is sufficient to **prevent water from running off** the façade.

Implementation
Pisé is a construction technique that involves **compacting** a mixture of gravel, sand, silt and clay in formwork (called "banches") to make up the height of the walls. Lime cords", visible between each "banchée", improve the erosion resistance of exterior facades by absorbing any run-off water to prevent it from digging into the earthen facade.

Vigilance points

Some buildings have deteriorated as a result of more or less recent interventions that were unsuitable for pisé. To avoid these problems, it's important to carry out a proper diagnosis and call in specialist craftsmen before any work is carried out on the building. The following sections outline the main points to watch out for when renovating pisé buildings

Hygrometry

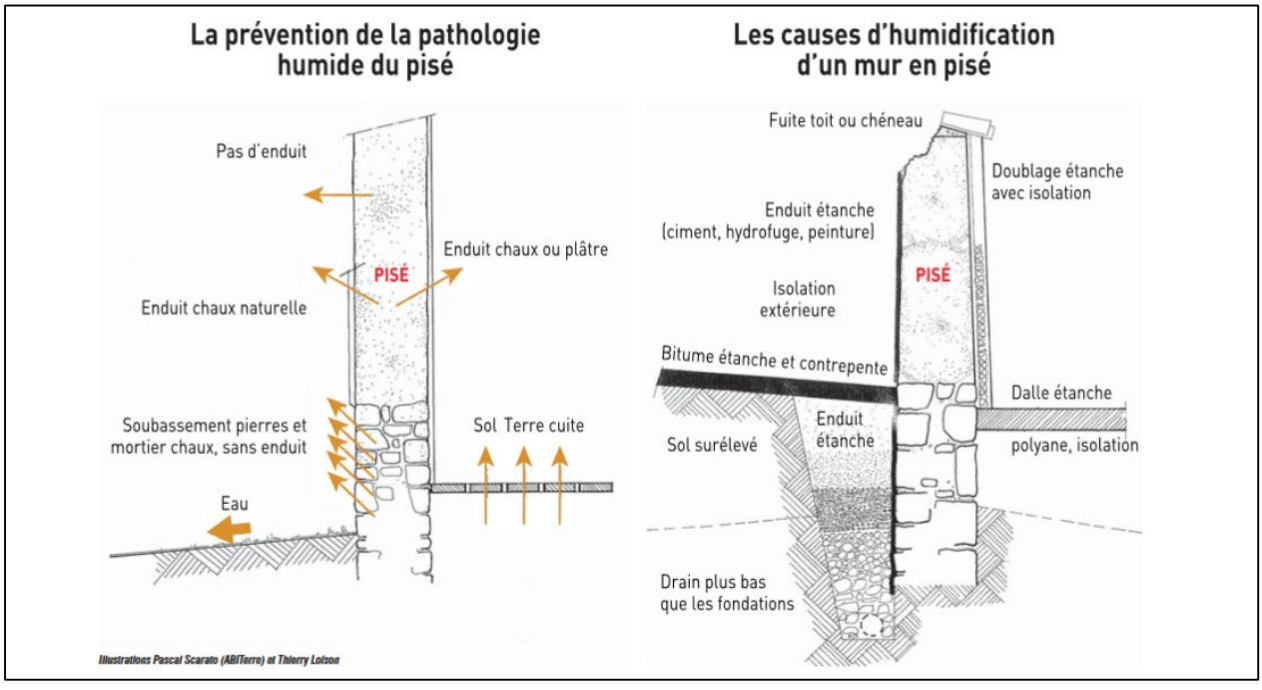
Pisé walls are sensitive to water and can be structurally altered if moisture accumulates in the wall. Moisture problems must therefore be treated as a priority.

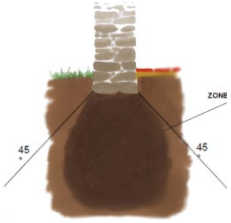
The first thing to do is to identify the source of the damp (capillary rise, slope of the land, inability to drain off water due to waterproof plastering...).

A few basic rules:

- Basements must be carefully considered to allow evaporation of rising damp.
- First and foremost, **avoid or reduce sources of moisture** : level out slopes that run in the direction of the building, avoid watertight coatings around the building (such as tar, cement decking, etc.), drain the periphery of the building (not too close to the foundations) and, where possible, the floor of the dwelling, and check that the roof overhang is sufficient. Install gutters.
- **Do not apply vapour-tight coatings** (on interior and exterior walls, but also on interior slabs).
- Install a **ventilation** system in the home.
- Choose exterior floor coverings to **avoid splashes on walls** if these are not plastered.

Widespread observation: under the cement rendering, the pisé has not been able to evacuate moisture. from capillary rise. The plaster is swelling and breaking up, and excess moisture has loosened the wall surface.





Structure of the Pisé wall

When renovating, rigid materials should be avoided wherever possible (e.g. wood should be used whenever possible if chain-laying is required).

When working in the vicinity of foundations, take care not to excavate in the vicinity of the compression bulb. This settling zone ensures the wall's stability. Use a craftsman familiar with the problems of old buildings (don't hesitate to ask for references).

Source : Maisons Paysannes de France

Cracks

Earthen buildings are often cracked, as earth is a material that moves over time. **Cracks can appear in pisé without necessarily threatening its mechanical stability**, but it is important to diagnose them and observe their evolution with the help of a **plaster witness**, which makes it possible to follow the evolution of the cracks. (photo opposite).

Cracks or minor damage

They can be repaired superficially with earth, in the form of liquid earth mortar or with lime grout. Cement should be **avoided**, as it stiffens the area and can aggravate the pathology.

Larger cracks

Openings can be filled with masonry elements (stone, mud bricks filled with earth or terracotta bricks filled with lime mortar) or the same pisé soil mixed with straw and sand. You must first ensure that the building is structurally stable (e.g. major cracks in corners or in line with structural elements), and call in a professional.

Exterior finishes

Render is not necessarily necessary on pisé: it depends on the quality of the soil, the purpose of the building and its exposure to wind and rain...
On the other hand, **it's essential that the exterior coating is permeable.** It's common to see pisé houses with cement rendering. In this case, it's best to **remove the plaster,** , especially at the foot of the walls, and **if you plan to insulate the walls from the inside.**

Lime plaster

Lime coating requires preparation of the wall, repairing cracks, reinforcing fragile areas (corners), levelling out the wall by adding earth coating or "planing" the wall. Lime is well-suited to pisé for its hygrometric properties (it does not block the passage of water vapor).

Energy renovation and pisé

Designing your project

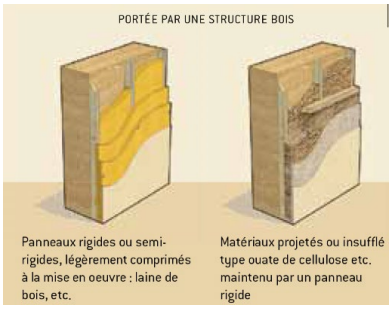
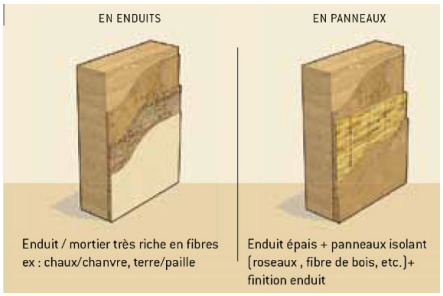
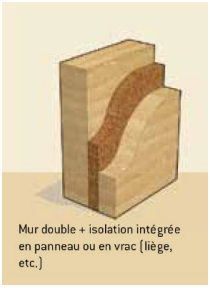
Designing a renovation project for pisé buildings requires the support of professionals experienced with this material. There is no national listing, and we invite you to consult our list of professionals (see listing at the end of this document).

Insulating pisé walls

The question of the appropriateness of insulating pisé walls does not always meet with consensus among professionals in the field, due to the material's sensitivity to moisture. Insulation options will therefore have to be considered on a case-by-case basis, depending on the condition of the wall. What's more, energy renovation needs to be **considered as part of a global approach,** assessing the energy-saving opportunities that are most worth pursuing.

If we focus on the subject of walls, from a thermal point of view, the relatively high thermal conductivity of pisé highlights the need for additional insulation. Although a pisé wall is more "insulating" than a stone or concrete wall, strictly speaking, it cannot be called insulating (50cm pisé ≈ 3cm polystyrene). **An pisé wall alone won't meet today's building performance standards**.

What type of implementation?

Type of insulation	from the inside	from the outside	by a double wall
Schematics *Source : Guide Livardois Forez			
Benefits	▪ Easy to install ▪ Preserves facade appearance ▪ Allows networks to be integrated without cutting into walls ▪ Can neutralize low-floor thermal bridging if there is continuity with slab insulation	▪ Preserves living space ▪ Eliminates thermal bridges on intermadiate walls and floors ▪ Minimizes the risk of condensation ▪ Preserves wall intertia (summer comfort) ▪ Takes advantage of pisé's natural moisture-regulating properties ▪ Protects walls from the effects of frost and rain, making them more durable pisé remains on the warm side of the wall, limiting problems associated with excess humidity in the wall	▪ Insulated walls maintain interia in summer ▪ Preserves the look of pisé
Disadvantages	▪ Reduces living space ▪ Does not neutralize thermal bridges linked to intermediate walls and floors ▪ Removes the benefits of the wall's thermal inertia (summer comfort) ▪ Can lead to condensation problems in the wall if materials and installation are unsuitable ▪ the pisé wall is on the cold side, and excess humidity can lead the damage	▪ Modifies the exterior appearance of the building by hiding the pisé ▪ May require the use of a mounting bracket ▪ Can lead to condensation problems in the wall if materials and installation are unsuitable ▪ Costly work	▪ Technique more commonly used in new construction, difficult to implement a renovation project

	major structures with walls that can suddenly collapse without warning in extreme cases		
Design rules	▪ Avoid empty spaces (unventilated or ventilated on inside air) between the wall and the insulation. ▪ Check the nature of the exterior coating. If the rendering is cement, it must be removed to insulate from the inside, otherwise there's a real risk of damaging the wall. ▪ Loose-fill insulation, or insulation fixed with earth mortar, is ideal for walls that are not perfectly flat. ▪ Use a humidity-sensitive vapour barrier. It must be installed with the utmost care. be careful not to use a vapour barrier that is too airtight. ▪ Ensure maximum continuity of insulation (e.g.: cut the floor between floors to ensure continuity of insulation).		▪ Insulation must be rot-proof ▪ The coefficient of resistances to water vapour diffusion must be close to that of pisé.
	▪ Materials used on the outside of walls must be more permeable than those on the inside, to allow water vapour to migrate easily to the ouside. ▪ Combine a mechanical ventilation system with all insulation work and changes to woodwork ▪ Check that the exterior rendering of the house is not waterproof (cement rendering, etc...) ▪ Do not use plant wool, plant fibers or cellulose wadding at the bottom of walls near foundations. These insulating materials are sensitive to prolonged exposure to humidity, so use rot-proof materials such as calcium silicate blocks (cellular concrete), cellular glass or cork on these sensitive areas to create a capillary break. The height depends on the case.		

Which materials to use for insulations?

In terms of humidity, the use of insulation unsuited to pisé can lead to condensation in the wall, resulting in structural damage.
The materials used on pisé walls must therefore be permeable to water vapor.

Insulation suitable for pisé: hemp wool, cellulose wadding, wood wool, straw, etc.

Materials not recommended for pisé:

- Synthetic insulation (polystyrene, polyurethane, etc.)
- Mineral insulation (glass wool, rock wool)
- Waterproof coatings (RPE, cement)
- Waterproof interior finishes (plasticized wallpaper, etc.)

Further information

Books and technical files

- **Réhabiliter le pisé, vers des pratiques adaptées**, *Actes sud, CRAterre*
- **Le pisé, Patrimoine, Restauration, Technique d'avenir**, *Les cahiers de construction traditionnelle*
- **Pisé H2O**, *Jean-Marie Le Tiec et Grégoire Paccoud, Ed CRATerre*
- **Bâtir en terre**, *Romain Anger et Laetitia Fontaine, Ed Belin*
- **Traiter de construction en terre**, *Hubert Guillaud et Hugo Houben, Ed CRATerre*
- **Terre crue : techniques de construction et de restauration**, *B.Pignal, Eyrolles, 2005*
- **La rénovation écologique**, *Pierre Lévy, terre vivante, 2010*
- **Cahier d'expert bâti en pisé**, *Pascal Scarato*

Specialized structures and lists of craftsmen

- **CRATerre,** laboratoire de recherche et conservation de techniques de construction en terre : http://craterre.org/
- **Asterre** Association nationale des professionnels de la terre crue
- **TERA** Association terre crue Rhône-Alpes
- **APLOMB** (formation à l'écoconstruction et la restauration du patrimoine) :http://aplomb.sud-gresivaudan.org/
- **Le Gabion** (Centre de formation professionnelle en restauration du patrimoine) : http://gabionorg.free.fr/
- **Maisons Paysannes de France** http://www.maisons-paysannes.org/
- **OÏKOS**
- **CAUE** (Conseil en Architecture, Urbanisme et Environnement) : www.caue-isere.org/

- Directory of Oïkos professionals: https://oikos-ecoconstruction.com/reseau-oikos/annuaire-pro/
- TERA Association: http://terre-crue-rhone-alpes.org/lassociation/
- List of Ageden craftsmen and material suppliers: http://www.ageden38.org/espace-telechargement/

Prepared in collaboration with:

Franck Janin
Heating engineer

Pierre-Antoine Chabriac
pisé expert, ENSAS

Grégoire Paccoud
Researcher pisé expert

avec le soutien de nombreuses intercommunalités