

## **Rondelet (1803) Theoretical and Practical Treatise on the Art of Building. Excerpt.**

Anywhere that adobe is used, the adobe block is made with clay soil. [...]. *In Persia, and in the Orient*, the masons, to make adobe blocks, knead the earth with their feet, adding short cut straw. They shape them in very thin wooden moulds. The dimensions of these are about 22 centimetres in length, 16 centimetres in width and 7 centimeters thick. When moulding them to make them more uniform, they pass their hands over them, after having wet them in a bucket of water, in which chopped straw is mixed (a finer straw than the one used to make the blocks). After 2 or 3 hours, these bricks acquire sufficient firmness to be stacked in an open space, in the shade, to finish drying.

House walls built of adobe blocks are covered with a clay and chopped straw render, which is enough to protect them from the rain. The top is covered with a course of burnt bricks, and sometimes adobe, angled to shed water.

The walls of more important houses are rendered with a mortar of lime mixed with (*gypsum*) plaster, crushed and mixed with water. This type of render is very solid and endures well in the air. This plaster is not as beautiful nor as white as ours, its grain being coarser.

In several regions of France, such as in la Somme, l'Oise, l'Aisne and la Marne, we build timber frames and we pack the infill panels with a mixture of crushed earth and straw or hay, which we call '*torchis*', wattle-and-daub, which is no better than the use of adobe blocks.

### **Article II Rammed earth**

Rammed earth is a method of building in earth which is even more simple than building with adobe blocks. It is very much used in the regions of l'Ain, Rhône and Isère. This cheap method, which make solid dwellings, safe from fire, would be worthy of spreading to other regions, where we build in wood, particularly for barns and other rural buildings.

When the walls in adobe are well made, they form a monolithic structure and when they have a good exterior render, they can last several centuries.

In 1764, I was in charge of the restoration of an old castle in the region of the l'Ain; it was built in adobe blocks more than a 150 years ago. The walls had acquired a hardness and consistency equal to the soft stones of medium quality such as Saint-Leu stone. We had – to enlarge windows and make new openings - to use a pointing hammer and a cutting tool such as would be used on stone ashlar. This type of construction, which seems to have been the practice in this country since time immemorial, was known by the Romans, Pliny talks about it as an extraordinary thing which must inspire admiration.

Method of making adobe blocks

Any soil which is not too fat nor too lean are good to be used for adobe. The best is the 'terre franche' (*agronomical soil stable in all its elements, assuring regular growth for vegetation, its theoretical composition would be: 65% sand, 15% of clay, 10% of humus and 10% limestone, souce Wikipedia*), which is a bit gritty. Any time a pickaxe, a spade, or a plow removes heaps of soil that need to be broken up, this earth is good for adobe (and rammed earth). Cultivated soils, garden soils, natural soils can be also used.

To prepare the soil, it needs to be beaten with a medium rake to extract any stones bigger than the size of a walnut. If the soil is too dry, we wet it by aspersion and stir it with a shovel. The soil needs to be humid enough that a handful, when thrown back into the mix retains the shape given to it in the hand.

When the soil is prepared, we throw it into a mould, or mobile box, where it is beaten by workers with a pestle.

*(This is now clearly about rammed earth...Rondelet uses the term adobe to describe rammed earth, seeing the product of each form as a giant adobe block)*

This box is formed with two boards of fir wood that the adobe makers around Lyon call *banches*, composed of tongue and grooved boards, strengthened with other boards laid across-ways and nailed. To facilitate the pose of these *formworks*, we put two handles on each.

These formworks are laid on transoms, and placed in grooves in the already existing wall. These four transoms are called *lassoniers* or *clefs*.

[...] We leave inside the formwork a space equal to the widest walls to be built - about 54 cm - and we decrease the width as the wall and the formwork are raised...

[...] such a wall will be 795 millimetres at the bottom and 108 mm narrower at the top...The *formwork* is usually 3,248 mm by 893 mm.

P233 Once the formworks are in place, we put mortar flashing, which we could do in plaster or even in earth, as it serves only to avoid the flowing out of the first soil thrown (*between the formwork as it meets the already constructed wall*). We then cover the top of the transoms with a small plank, placing also along its length firmed earth mixed up with water, that is to say, a bit wetter than the rammed earth mortar.

Then we put as many rammed earth-makers as there are divisions in the formworks. After the bottom has been cleaned and wetted, the labourers carry the ready-made soil to the rammed earth builders in wicker baskets. They spread the soil with their feet to form a layer of uniform thickness, which should be no more than 10 cm.

Then, each of them a pestle, they ram this layer of earth, reducing it slowly to half its original thickness. This first layer compressed, the labourers bring more soil to form a second layer of the same thickness and do the exact same thing.

To talk about the pestle in detail: the flat part of the pestle with which the

worker hits the soil is the most essential part. It needs to be very uniform and smooth. Good rammed earth builders are proud to have a good pestle that can hit the soil in any part in the box. We choose for this tool a hard wood, such as the roots of elm, ash or walnut trees.

We use the pestle by turning it after every hit, in such a way as to cross the imprints left on the layer, beating it everywhere equally.

When we begin a wall, we put at one end of the formwork, a closure of two boards joined with bars (*to prevent spillage and allow for full compaction*). The other extremity is finished to a 60° slope. This is done to link the first section to the one that follows.

The first section finished, we dismantle the box to place it right next to it in such way that the formwork entirely surrounds the sloped area that ends the first one. We follow the same methods back and forth along the wall...

[...] When the rammed earth walls are finished, they need to dry for a time, the period dependent on the temperatures of the country and of the season, before being coated with a render, whether of plaster (*of Paris*) or mortar.

Even though rammed earth is made with just barely moist soil, whilst adobe blocks are kneaded with straw and water, it is important to be careful and remember the observation of Vitruvius about not applying a coating to a wall built this way before being certain it is dry. Rammed earth made during high temperatures is soon dry on the exterior but humidity will remain present to the interior, from whence it will escape slowly to the surface. If this surface has a coating, this will detach, the water being trapped between the surface and the coating. One should not be scared to let the rammed earth dry when it is done well, because the drier it is, the better the coating will stick to it. I saw, in the region of l'Isère, very old houses, built of rammed earth, that had never been coated/rendered/limewashed but had nevertheless been resistant to all types of weather.

My advice to those who wish to use this cheap building method would be to consult the books of Cointeraux, Professor of rural architecture, who studied this type of construction with great zeal and success. He has published several books with infinite interesting detail essential to success. However, as I had the opportunity to run (*projects with rammed earth*), I will conclude indication of the method which has suited me perfectly and which tends to give the rammed earth more tenacity.

The alterations I was in charge of to the castle before-mentioned, were to the main building, raised two stories and an attic. The soil I had to use was, to my knowledge, a bit dry and of mediocre quality. To compensate for these inadequacies, after beating it in the normal way and stirring it with a rake, I **moistened it with milk of lime instead of pure water**. This simple method produced a rammed earth with more firmness and consistency than the one

made with good soil. Its surfaces were so hard and smooth that we did without any coatings on this and several other buildings. We only whitewashed the surfaces with lime. As to the main building, the walls were covered with a mortar layer made of lime and sand (*plaster*) because it was next to the castle's apartments and seeing it, we would have never guessed that it was a construction in earth.

It is clear that with this method, we could use adobe blocks as the ancients did it, which would have more consistency and solidity.

[...].