

Cointeraux F (1790). Rural school of architecture or lessons from which we will learn ourselves how to build in a good manner several story houses in earth only, or in other most common materials, the cheapest way. Paris, Chez l'Auteur.

Introduction

The potential to raise a house to two, even three stories with only earth; to carry on their floors the heaviest burdens and to install the heaviest materials, surprises everyone or, rather, those who have never been able to see these original constructions. It is to convince them that I will start with the art of rammed earth, this lesson is urgently to be taught in order to accelerate the multiplication of these smalls properties in the countryside so desired by the king and repeated by a thousand authors.

If I am happy to satisfy my compatriots, I should hope from them sufficient assistance, since without it I could not complete this essential enterprise. They see at least, perhaps, in the purchase of this little treatise, a patriotic contribution, to help me spread in all parts of the kingdom a new art which on its own can prevent the countryside from the scourge of fires, for it can be achieved by the poorest owners.

P5 Origin of rammed earth

Rammed earth is a manual operation, really easy; it is [done] by compressing the earth in a mould or in a formwork by which means we can build small, large and tall houses. 'Le pisé' [meaning the choice of word] would have more meaning if we would use 'massive' or monolithic because the building is a true monolith - it has no joint, whereas mortar offers innumerable joints for the binding of the stones. But we have to abide to the workers' terms, in all these vulgar denominations that we had been forced to adopt in the French language, however I inform you that I will use, indifferently in this book the words piser, massiver, presser (to press), comprimer (to compress) or battre la terre (to beat the earth).

The origin of rammed earth, somewhat unknown in France, forgotten in the others countries goes back to the first centuries according to Pliny, and it seems Noah was the inventor 'who learnt from the swallows' nests. Whatever it is, it is clear the ancients knew and practiced this art.

M. Goiffon claims the Romans used rammed earth : '*we easily conceive why this custom which does not have in principle a real utility can be circumscribed in a province*'

But we cannot understand this reason of this localism, if we can express ourselves in that manner, for [this custom] is for the common good by its economy of raw materials and by the diminution and the speed of the work. The art of the rammed earth worker, we maintain, has these advantages. This art of building in rammed earth has been transmitted from generation to generation in the region of Lyon, in an uninterrupted succession going back to the Romans who used to live there and presumably brought it, such as they did with the culture of vines and many other arts in the practice in which we still find their terms and their genius.

M. the Abbe Rozier discovered the use of rammed earth in Catalonia. Spain, as well as France, has, therefore, at least one region where they have perfected this ancient method of building.

Here, we use it in the surrounding provinces of the Lyonnais, it is only in parts of

Dauphinois, Bourgegne and Vivarais where we use it. La Bresse has excellent earth to use but they still build in wood. Rammed earth spreads very slowly. It needs to be propagated, particularly in the regions north of Paris, where the materials are rare and lacking. It also needs to be used in the mountains, in the valleys, where transport is difficult, often impossible, for rammed earth's only cost is the workforce, excluding all sort of materials, any transports and all sorts of preparation. Lastly, we need to build farm buildings in the countryside with this method. Because we have to make these big for the farm operation and for the voluminous crop, the buildings currently incur great costs and insufficient return.

(Describes the tools needed with drawings and then continues with : The other tools you will need are pickaxes or spades, shovels, baskets or hods, a gardener's watering can, trowels, a mason's lead (plumb-bob), an axe, hammer, carpenters' sergeant (a metal or wooden bar, ending with a flattened hook, used to keep pieces of wood tightly together), a mallet, a saw and nails.

p10 Construction of the mould

We take planks each 10 feet in length, of white wood in order for the mould to be lighter and to be pliable and more easily transported by the workers. Fir is without doubt the most suitable wood because it is less subject to deformation. It is also for this reason we choose the driest, straightest and healthiest boards in which there are fewer knots.

The most usual height of the mould is about 2 feet 9 or 10 inches if we put three boards for each side of the formwork. [...]

The six or seven chosen boards have to be smoothed on their interior sides with a plane. However, this can be omitted on the outside, for it is only the interior sides that should form the smooth façade of the wall. However, my experience taught me that this negligence has repercussions. The soil sticks on the exterior sides which were not whitened, making the mould heavier, particularly during raining times, whereas when smoothed or made uniform with a plane, we can always keep it clean with a straw cloth.

p17 Tool with which we beat the earth

The most important tool for rammed earth, upon which depends the building's solidity, its strength for several centuries, in a word, its perfection, or on the contrary, its bad quality is [the tool we use] to work the soil. We should not be mistaken, this type of construction has two extremes, whether perfectly good or excessively bad. This tool is called the pisor (rammer).

We begin by taking a piece of hard wood, whether oak, ash or beech and everytime we could get the shoulder or roots of these trees, even of elm and walnut and others. We must prefer them because of the close union of their pores or ligneous parts. *(After that so many details of dimensions etc.)*

p19 The practice of rammed earth

We should not be mistaken! Rammed earth is quite different from those miserable constructions made with kneaded earth, or mud, mixed with straw or hay that most people mistake for this precious art. I even saw clever (skilled) people who did not know or did

not want to distinguish this noble science from the routine we can see in the countryside to raise a few walls with kneaded earth - most vicious constructions, for they only support themselves if given a batter.

The art I am presenting contains all the principles of the best masonry.

Then he says he'll take an example by building a house with the reader.

We will start by making the foundation of this house with an ordinary masonry which we will raise at first to 2 feet above ground. This cost is absolutely necessary to prevent humidity from the ground. Moreover, this also protects the walls from the rain water from the gutters. When all the levels of the walls are 18 inches of thickness, we will draw on top of them with black or red stones, trenches to receive the mould key. Their distance should be of 3 feet from centre to centre. [...]

After marking these trenches, we will build another 6 inches of masonry, which will leave room for the keys and at the same time with those extra 6 inches, would give in total 2 and a half feet of substructure in stone and mortar. This height is enough to avoid damaging the earth wall from the rain and snow. On top of this fresh masonry, we will set up right away the formwork, placing it at one angle of the house [...].

When everything is in place--> : Each mason enters his space; we need three men for the 4 rows of uprights form three spaces. We place the best worker in the angle, it is him who is in charge and from time to time checks to see if the formwork is leveled. However, each mason should have with them their *lead* (plumb bob and line) to also check.

Before putting in the soil, we will spread a glaze of mortar, only around the formwork and cover with a few stones the trenches where the keys are. This glaze only serves to stop the earth that we will throw in from going into the joints and also to allow compression of the soil in the angles of the formwork.

The other workers, who dig the earth, prepare and carry it to the formwork. They give some to the three rammer workers. They first spread it with their feet and then use the rammer, being careful to only lay in each time from 3 to 4 inches of thickness. The first hits they give are around the angles of the mould, after that, they beat evenly everywhere in the mould. After that, they cross their beats in order for the earth to be compressed in every direction. When two masons meet around the edge of their space, they coordinate their beat to hit at the same time under the cords because they can only compress the earth with difficulty and diagonally. With this method, the entire length of the mould is equally rammed. The one who is in the corner beats with care against the head of the mould and for vanity, or for reasons of solidity, he lays on the compressed earth every six inches of height, a thin bed of mortar against the formwork, which imitates the joints in stonework.

Piseurs (rammer workers) do not add any earth before the first layer is well compressed, indicated when the rammers no longer mark the soil. When they are assured of its perfection, they call the labourers to carry them new soil which they will compress again, layer by layer until the mould is completely full.

When achieved, we will have no fear of removing the mould right away. The earth wall freshly made, about 9 feet in length and 2 and a half feet in height, will stay on his foundation, straight, and in no danger of falling. We will then immediately slide the formwork along the wall and touch the newly made one by just an inch, above the slope. We will have left on the opposite side of the corner, a slope. [...] this slope is usually about

1 foot and a half of width horizontal. With this method, we do not leave any joint, we bind each segment of wall together for the second time we compress the earth, we will compress it in this inclination, as we beat new soil on the older earth already rammed.

To make the work goes faster, I made a new tool I call *pioche tranchante* (sharpened pickaxe). One side has an axe, the other has the shape of an ox-tongue, it does not finish as a point like a needle but it extends of the same width, slightly curved and sharpened. I would recommend forging this tool as it is very practical and allows you to work faster. (*A mattock*)

(Then he goes on, saying if you start your wall on the left side, you start the next level on the right side and back and forth until the wall reaches the required height).

With this precaution, we locate all the inclined junctions of the walls opposite directions, which contributes in its solidity.

On these elevations (refers to two drawings at the end of the book), we will find this simple construction is as good as the best masonry.

Such is the rammed earth method used in the Lyonnais for centuries. The houses built that way are solid, healthy to live in, cheap, and they last a long time even when left in a bad state. I destroyed some where the titles of ownership went back to 165 years. The rich merchants of the city of Lyon had their country houses made the same way. The render (plaster) with the paint, which is again very cheap, deceives the eyes as to the nature of these houses, and, covering the earth, decorate it exquisitely.

This fresco paint is happier, fresher, shinier than other paints because water does not alter the colours. Thus, we do not use glue or oil. The cost is almost only in the labour, for the rich as for the poor. With a bit of money spent on red ocre, yellows or other colours, the owner can make his house sparkle.

Every stranger who has traveled on the River Saône, or in a stagecoach, has never doubted, upon seeing these beautiful, charming country houses raised on the hillsides, that they were built of earth. How many people have visited or even stayed over in these castles, without noticing their singular construction? ...The wealthy farmers limewash them (or whitewash, no precision). Some of them, more glorious, add pilasters, doorframes, ornamentation of various colours.

Allow me to say that we should employ this type of building across the kingdom, whether for the decency of the villages and the honour of the nation, whether to spare the wood we use in such great quantities, whether to avoid fires, or whether to guarantee the farmer against the cold and excessive heat and also to conserve his health, or whether for so many other reasons, too many to say, so useful to the state and to the owners. For example, because [this type of construction] offers a diminution of work and a faster building technique, as well as the benefit of being able to move into these houses almost immediately after they are built. It is why, when the roof is installed, we do not block immediately the (putlog) trenches, because the air circulation passing through the walls, helps to dry them out faster, which makes the houses even more habitable sooner.

We leave the openings of doors and windows during the building of the walls. Everytime the mould meets a wall where a door or window will be, we put two head moulds, or one,

to form the jamb. We put them oblique on the inside to give the necessary flaring [...]. The door and window framings can vary. The wealthy use ashlar or bricks, the less fortunate use wooden frames. But wood is harmful to the decoration as wood cannot bind with rammed earth. This bad effect is shown here (*Drawings but the quality of the PDF is bad, can't really see anything*) where we will notice, despite great precaution, the renders are detaching from the pisé and fall from these wooden frames; whereas stones and bricks bind really well with the pisé, and hold the render tight, so that the paint lasts much longer.

Stone or wooden fireplaces are installed into the rammed earth as easily as into a masonry wall. Pipes can also be fixed in a very solid way.

But what is singular and greatly advantageous is that we can decorate with nobility (great, expensive taste), without having to put any jambs in the interior doors neither in stones, bricks nor even wood. They can simply be made in earth. And why would we spend on jambs when we can simply install the doors on the wooden panels?

We can see how much we could save on this admirable type of construction. By which turn of fate did this art remain confined to one region? Why even today, is it forgotten or ignored by the whole universe. Again, it is only by spreading this cheap method to all parts of the kingdom, as well as other ones, as I will discuss further, that France will maintain the priority of growing its agriculture, commerce and industry.

It is only too true that the simplest methods, thus the best, stay forever in villages where a few geniuses invented them. The one I now am going to talk about will surprise the reader who will not conceive why and how the Lyonnais does not use it.

The other method of rammed earth

It is in some part of Bugey in Bourgogne where an imaginative skilled worker, even an illiterate, discovered this new method. The entire population of the township (canton) adopted it for its great simplicity and, so much so, that they do not know any other method.

We are pleasantly surprised to see houses which seem to be built in one piece; when examining them closely, we cannot see any joint, there are no holes unpleasant to the eye that we forced to create for the keys.

If the question, published 6 years ago, of preventing fires in the countryside hadn't forced me to work seriously and, for this reason, to travel to make record in the villages, the various methods of building and the singular materials, particularly the ones we can use with success and economy against this disastrous occurrence, I would not have come to know this method of making rammed earth.

However, being close to Bugey in Grenoble, where I imagined there would be all sorts of ways to build against fire and cheaply, my experiences even brought me to discover that we can build vaults in earth only, but I never thought it possible to shorten the work of the Roman rammed earth.

To my surprise and joy when I arrived in the Bugey, I realised we could build in earth differently than by the method I saw in Lyon, in my youth, that my grand-father, master

mason, and that I myself, practiced all our lives. These are big houses all in one piece....We cannot see on the rough facade, usually from the hand of the worker, any keys or joints on the walls. Everything is whole from the ground floor to the roof.

Practice

This method consists 1° commonly build a stone wall substructure of 2 feet and a half. 2° to put in parallel wooden poles, 3 feet apart, in the ground on each side of the stone wall. 3° Space the poles of at least 2 inches from the wall 4° fill in the holes we made from one to 3 feet deep depending on the tenacity of the terrain. This filling in should be done by compressing the earth around the poles and a bit more above ground level with the rammer.

The poles, once put in straight all around the building and on the interior side of the wall, it remains to attend to the rammed earth work. We avoid thus all the repeated labour of the other method such as making trenches, of continually moving and replacing the keys, the putlogs and quoins.

Starting the house at a corner, we place between the 4 rows of poles, the large boards and we tighten them with 4 cords. We place at the same time the head to form this corner and to stop it, we put the *sergeant* (wooden or metal bar with a flattened hook) that we hit with a wooden mallet. A metal mallet would soon damage the *sergeants*.

After having rammed the first phase of the wall, we loosen the cords but the workers should support the mould and together slide it between the next poles where the cords are once again tightened for the second segment. We follow the same process all around the building and then do the same with the inside walls.

For the second course, we start again at the same corner on the left, if we left on the right to cross them and link them together, by stopping however against the partition walls [...].

p42 We use the same method for the third and all the others up to the correct height. It is useless to remind you that we have to put the mould at least 3 inches on the lower segment under it, that the workers should check the formwork has not moved with the hits of the rammer and at last, that the centre of the wall they are building should be straight or perpendicular, and that it is only the inclination of a line that reduces the thickness of the wall for every course.

The unique cause for the courses not to have any joints are the omission of the mortar around the mould. The workers of Bugey pushed economy to the extreme. But we know that with little lime and sand, we could joint all courses of a house.

The people of Bugey are not only great savers but also very skilled. They have no problem to lay, align or work in a short amount of time, these big poles which seems quite difficult for a theoretician. It is true, practice overcomes all obstacles and I have no doubt, once the workers get used to this method, they will execute it with an ease and dexterity in all regions of the kingdom.

I have to say in the Bugey, the buildings are not as high as the ones in the Lyonnais, because we understand the difficulty of keeping the poles straight in the ground, almost as tall as the corn we sow in the village, for it is possible to build with earth a house more than 36 feet of high. I built my own house in Lyon, which is very solid, higher than this.

Often we cannot find poles of sufficient quantity or length, so we use the wood we have, removing the timbers as each segment of the wall is finished and replanting them along it for the following segment and so on, in order finish it. The workforce would be greater but the cost of wood less - one compensates for the other.

Concerning the length of these poles, if they are smaller than the height of the house we want to build, we can build a building up to the height of the poles and then place the keys to finish the house, particularly the gable, (by the old method).

Overall, I will observe that both methods are very useful, and should be equally adopted and spread in France because they can be used separately or used their combination.

P45 The Bugey method would be excellent for barns, stables, farms and all other buildings related to farming. The Lyonnais method is advantageous to for building higher houses, such as for wealthy people, or manufacturers, factories, hospitals, presbyteries and public schools etc.