

Precis of use of the natural hydraulic lime NHL



*« Or, how to use nature to protect us
from its whims ».*

Olivier Labesse.

*To my father,
a man, i own everything.*

Preface

There has been an on-going renaissance in working with lime throughout Europe during the last twenty years or so. Some countries had abandoned lime completely in favour of cement; when lime was used it was only to increase the workability of cement mortars. Working with lime was all but forgotten, repairs to old buildings were carried out using cement mortars and concrete. As a result problems began to occur. It was realised that old structures originally built with lime were best repaired using lime. In simple terms old buildings needed to breathe in order to stay dry and healthy, and to remain flexible so as not to crack from inevitable minor movement.

Working with lime had to be re-learned again. In some countries nobody still living had worked with lime or only the very old had the dimmest memory of doing so. Written sources were scarce and sometimes confusing. Initially mistakes were made but bit by bit knowledge and skills were re-developed. There is still some way to go.

France was fortunate not to have abandoned its natural hydraulic lime production, which it has maintained since the 19th century. Today it has a thriving export business because of renewed demand worldwide. Lime is once more spreading across the world for use not just in the repair of old buildings but for the construction of new build (without cement) as well.

I first met Olivier Labesse in Ireland in the early 1990's when we worked together without mortar, building dry stone bridges. He was a young man passionate about stone and lime and the things he had learnt about building as a boy. He went back to France but returned a few years ago and worked at lime plasters and renders on historical structures here in Ireland.

Olivier Labesse presents here with inevitable passion his methods of working with natural hydraulic lime, learnt as an apprentice with his father as Limousin's mason, in France.

Patrick McAfee

Introduction

Since early childhood I was taught how to use lime correctly by my father, a Master Craftsman Mason and Plasterer. In those days there were no standards as exist today for the materials or the finished work and my father had to make his own hydraulic lime by mixing cement and hydrated lime.

In France legislation required contractors and companies wishing to work with lime to take out insurance, known as « decennale » providing ten years of cover. However, now that Natural hydraulic lime (NHL) is standardised, the use of NHL fulfils this cover requirement.

My intention with this book is to give a clearer understanding on why I now use only Natural Hydraulic Lime. The standardisation of NHL into three classes assists in ensuring that the correct lime is used to suit the prevailing conditions.

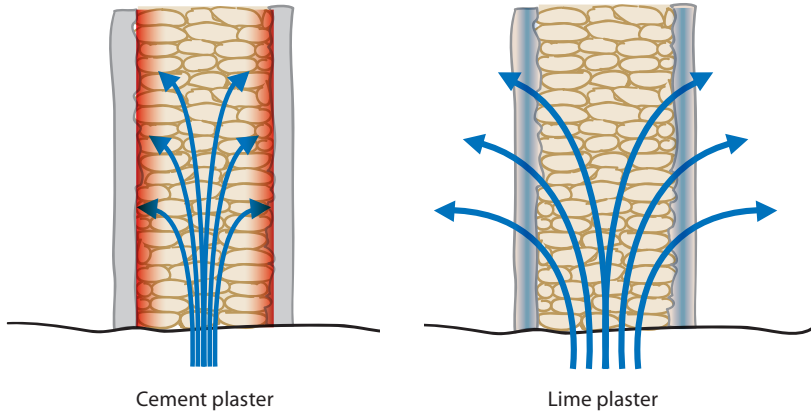
I'm not just sure that the end of the second paragraph is what you intended.

Olivier Labesse
Maçon Limousin

Table des matières

Preface	p. 03
Introduction	p. 05
1 CEMENT	p. 09
2 LIME	p. 09
3 PROCESSING	p. 11
3.1 Extraction	p. 11
3.2 Firing process	p. 11
3.3 Tools	p. 11
3.4 Spray gun	P. 12
4 STANDARDS	p. 13
4.1. NHL	p. 13
4.2 NHL-Z	p. 14
4.3 CL 90	p. 14
4.4 DL 80	p. 15
4.5 Others	p. 15
5 LIME PLASTER	p. 16
5.1 Ingredients	p. 16
5.1.1 Sand	p. 16
5.1.2 Pigments	p. 18
5.2 Preparation	p. 19
5.2.1 Dash coat	p. 19
5.2.2 Scratch coat	p. 21
5.2.2. a Scratch coat or « refourmi »	p. 21
5.2.2.b Hemp	p. 23
5.3 Finish coat	p. 24
5.3.1 Rough finish	p. 25
5.3.1.a Spanish finish	p. 26

5.3.1.b	Rustical finish.....	p. 26
5.3.1.c	Float finish	p. 28
5.3.1.d	French float finish	p. 28
5.3.1.e	Normal float or used French float	p. 32
5.3.1.f	Scratch finish	p. 32
5.3.1.g	Repointing	p. 34
5.3.1.h	Rusticated stone finish	p. 36
5.4	Smooth finish	p. 38
5.4.1	Limewash	p. 38
5.4.2	Silica sand	p. 39-40
6	MASONRY	p. 41
6 1	Wall masonry	p. 41
6.1.1	Soft stone masonry	p. 41
6.1.2	Masonry hard stone	p. 42
6.1.3	Very hard stone masonry	p. 42
6.1.4	New bricks masonry	p. 43
6.1.5	Stone replacement technique	p. 43
6.2	Ground masonry	p. 44
6.2.1	Lime concrete	p. 44
6.2.2	Coping	p. 45
7	CLAY MASONRY « PISE » AND «TORCHIS» (COB)	p. 46
7.1	Pise	p. 46
7.2	« torchis » (Cob)	p. 46
7.3	Double lime bending.....	p. 48
8	LIME ON WOOD	p. 49
8.1	Animal's hair	p. 49
8.2	Plastering a wooden piece.....	p. 50
9	LIME AND GYSPUM	p. 51
	Conclusion	p. 52



On this wall, the stain is caused by the damp because cement plaster was on it before.

1 - CEMENT

Cement is produced by heating 80 % limestone with 20 % clay to around 1450 ° C (2642° F), which leads to it setting very hard when used.

Let's imagine a plastic bag stands for cement and a wet cloth represents a wall. Put the wet cloth into the plastic bag and wait for some days. The piece of cloth gets spoiled. It is the same result for a wall because it has to be kept dry. Contrary to lime, cement prevents the wall from breathing and imprisons moisture, making the stone friable and damp.

2 - LIME

Lime has to be burned to around 1030° C (1886° F) It is breathable and enhance the living environment.

Talking about masonry, moisture often triggers problems in stone walls, baked clay, clay or bricks. Lime resists water penetration and reduces condensation while allowing the wall to breathe freely.

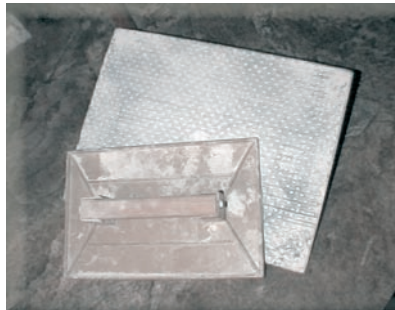
This is why it seems to me that lime is an essential construction and plastering material and it has always been with us till now, up to the XXIth century



Three tools needed for plastering



Small pick axe for stripping plaster



French float



Trowel

3 - PROCESSING

3.1 *Extraction :*

Natural Hydraulic Lime (NHL) comes from siliceous limestone strata at 8 % for NHL 2; 10% for NHL 3.5 and 12% for NHL 5, for some of them, but for others, they are using the same siliceous limestone, only the cooking and the cooling are making the difference..

3.2 *Firing process :*

Siliceous limestone has to be burned to around 1030°C (1886° F) so as to be transformed into agglomerate called quicklime that will be ground, pounded and put into bags.

3.3 *Tools :*

The tools you will need depend on the work that has to be done. They are not too expensive anyway. You can be sure that a good old tool is of better value than a cheap one that you will need to replace frequently. As for me, I will not ask you to consider one brand more than another. Every man to his own taste. Nevertheless, I must confess that my trowels come from foreign countries. I find these ones more pleasant to use than the trowels I can find in France.

3.4 Spray gun :

The compressed air spray gun can be used with a diesel compressor in such a way that it prevents you from getting what is commonly called tennis elbow.

You have to connect the spray gun to the compressor and it requires a minimum pressure of 4 to 8 bars. It can be used for rendering and repointing, depending on the pipe and the three holes small plate that you will choose to fit as a ferrule.

You have to be physically strong enough to fill up the pot with mortar and hold it out and up to the wall. The pneumatic spray gun goes like a sub-machine-gun except that mortar comes up out of it instead of balls. The speed projection with compressed air dries mortar; consequently make sure your mortar is fluid enough from the start.

Personal equipment :

You must provide yourself with a mask, gloves, and coveralls.

Last but not least, because spending a certain amount of time rendering walls this way can be very noisy, let me advise you to use a sound-proof helmet.

Use the pneumatic projection pot just as if you would throw mortar up with the trowel.

4 - STANDARDS

4.1 NHL or Natural Hydraulic Lime :

There are three sorts of NHL,

NHL 2, NHL 3.5 and NHL 5.

The indications 2, 3.5 and 5 represent the N/mm² compressive strength at 28 days. The NHL 2, 3, 5 is made Natural Hydraulic Lime (NHL) comes from a siliceous limestone strata at 8 % for NHL 2; 10% for NHL 3.5 and 12% for NHL 5 for some of them, but for others, they are using the same siliceous limestone, only the cooking and the cooling are making the difference.

Tableau des normes et des chauffourniers

REF COMPAGNY	NHL 2	NHL 3.5	NHL 5
BLUE LIAS LIME	×	×	
ROUND TOWER	×	×	×
BRECKWEG	×	×	
CASTLE CEMENT	×	×	×
SAINT-ASTIER	×	×	×

4.2 NHL-Z:

Natural Hydraulic Lime (Z) has an increased compressive strength thanks to the addition of a hydraulic element (not more than 20%) such as cement, pozzolana or any other binding material. To know more about the adjunction rate, please refer to the “Lime Manufacturer” (a lime manufacturer) cards.

Mixing lime with pozzolana is a process known from antiquity. Vitruvius (Marcus Vitruvius Polio) devoted a chapter to this process in his treatise “About Architecture”, a reference up to the XIXth century for architecture and building.

The hydraulic characteristic of silica remained unknown in those times, and Vitruvius wrongly thought that the sulphur contained in pozzolana made the lime set harder.

The hydraulicity level determines the ability to set in water. Siliceous clay burnt with limestone leads to a natural hydraulic lime. The higher the compressive strength is, the harder the lime sets and the more rigid and grey in colour it will be.

4,3 CL 90 Calcic Lime:

It is a non-hydraulic lime (“common lime”) made from pure limestone at 98%.

4,4 DL 80 Dolomitic Lime:

This lime is made from dolomitic limestone. It is also a pure non-hydraulic lime at 98%, the only difference is the percentage of magnesium.

4.5 *The others :*

Other lime manufacturers did create their own lime recipes, these would belong to some sort of hydraulic limes rather than the non-hydraulic ones, but I do not know their compressive strength or their durability.

Although these limes can be assimilated to hydraulic limes, they cannot be used upon any **support** or in any type of masonry, contrary to the Natural Hydraulic lime that responds to the **AFNOR** regulations and European regulations.

5 - LIME PLASTERS

They are composed of three coats all composed of water, local sand and lime, to which we can add some colour made from pigments or coloured sand.

5.1 Ingredients :

5.1.1 Sand :

Sand will constitute the bulk of the plaster as well as the aesthetic finished look since the coloration of the final product depends on the colour of the sand when mixed with more or less white lime. It is an indispensable ingredient for construction and plastering.

« He was victim of cement, which made him a granulate without relief. Indeed, the industrialization of uniformed “sand” provided an answer for the demand of the homogeneity and the neutrality cement mortars needed. On the contrary, natural lime plasters need various types of “sand” which choice will determine the aspect and the plaster’s quality. This choice is based on historical, scientific technical and economical knowledge elements ».

« Les Sables », edited by
ARTEFAB pays de Loire

Tel . : +33 (0)2.40.89.30.22.

« In buildings of rubble work it is of the first importance that the sand be fit for mixing with the lime, and unalloyed with earth. The different sorts are these; black, white, deep red, and bright red. The best of each of these sorts is that which, when rubbed between the fingers, yields a grating sound. That, also, which is earthy, and does not possess the roughness above named, is fit for the purpose, if it merely leave a stain or any particles of earth on a white garment, which can easily be brushed away.

If there be no sandpits where it can be dug, river sand or sifted gravel must be used. Even sea sand may be had recourse to, but it dries very slowly; and walls wherein it is used must not be much loaded, unless carried up in small portions at a time. It is not, however, fit for those walls that are to receive vaulting. In plastered walls, built with new pit sand, the salt, which exudes, destroys the plaster;

But plaster readily adheres to and dries on walls built with new pit sand, and vaulting may safely spring from them. If sand have been dug a long time, and exposed to the sun, the moon, and the rain, it loses its binding quality, and becomes earthy; neither when used does it bind the rubble stones together so as to prevent them sliding on their beds and falling out: nor is it fit to be used in walls where great weights are to be supported. Though pit sand is excellent for mortar, it is unfit for plastering; for being of such a rich quality, when added to the lime and straw, its great strength does not suffer it to dry without cracks. The pooriness of the river sand, when tempered with beaters, makes the plastering as hard as cement ».

(Vitruvius, Roman architect 1 century before J.C.)

5.1.2 Pigments :

I am not talking here about artificial colours because having observed my father working since I was six, I can ensure you that artificial colorants do not last very long, compared to natural colorants.

We can also use naturally coloured sand, as mentioned in Vitruvius's treatise.

Beware of clayey sands ; they tend to weaken NHL based lime plasters given that heated clay is already a constituent of NHL.

5.2 Preparation :

Currently plasters are applied in three coats: dash or scud coat, scratch coat and a finish coat. These three steps were created by DTU (Documents techniques Unifies / United Data Sheet), the building Bible. Nonetheless, after numerous “strip off” (a technical term for taking off old plaster) I noted that lime plaster application was different before the advent of cement.

Through this Accurate, I propose to you to work plasters in the old way using materials of the present time.

5.2.1 Dash coat :

Dash coat board

Light concret / soft support Soft stone	<i>1,5S/1C</i> - NHL 2
Stone Old bricks	<i>1,5S/1C</i> - NHL 3.5
Slag	<i>1,5S/1C</i> - NHL 3.5
Cold stone Concrete New brick	<i>1,5S/1C</i> - NHL 5

S sand for the part of Sand and **C** stands for the part of Lime.

1 Bag of 25 kg for 25 yard square

I think the dash coat when applied to stones is something to handle with precaution. Firstly, point any open joints in the stonework or to avoid any future movement or cracking of the scratch coat.

Structures, rough casted, or masoned with clay or lime, allow minor building movement to occur and minor cracks can occur. For this reason it is important to consolidate the background structure by reappointing etc before coating with the scratch coat.

The usual ratio is :

1.5 part sand to 1 part NHL 2 lime to cover up soft materials;

NHL 3.5 upon firm materials,

NHL 5 upon hard materials exposed to wind and bad weather conditions seafront, mountains or really hard support as concrete blocks ...

5.2.2 Scratch coat :

5.2.2.a Scratch coat or « Refourmis » :

The scratch coat is also a consolidation coat for masonry. In my opinion and despite what purists may say, this coat is a plastering coat made for reappointing, consolidating and grip, and not for flattening. This may seem rather difficult considering the surface of a stonewall are basically not straight.

Ratio board for scratch coat or « Refourmis »

	< 1 cm	> 1 cm
Soft stone Light concret Slag	NHL 2 2S/1C	2,5S/1C
Hard stone	NHL 3.5 2S/1C	2,5S/1C
Cold stone Concrete New brick	NHL 5 2S/1C	2,5S/1C

S sand for the part of Sand and **C** stands for the part of Lime.

1 Bag of 25 kg for 25 yard square

This coat has to be thrown up and on to the wall because if you trowel the coat too much, the lime will come to the surface and prevent the finish coat from sticking properly. Coats can become dry or desiccated.

It is true that a stonewall's charm is that it is slightly uneven, this will not affect its longevity at all and the wall may stand for 500 years or even 1000 years. The main quality of lime is that it lets the wall breath, which is not the case with cement.

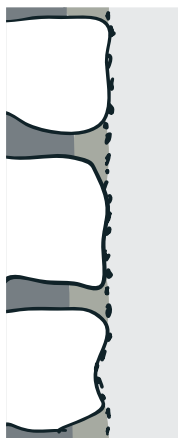
The usual ratio is :

2 parts sand to 1 part lime for a coat thickness up to 1 cm or 1/2 inch

2.5 parts sand to 1 part lime for a greater coat thickness or up than 1/2 inch up to 1 inch

Make sure the area that is to be plastered is perfectly clean and sound. Keep in mind that successive coats have to contain proportionally lesser amounts of lime in order that they diminish in strength from the background support to the exterior.

As a matter of fact, your scratch coat ratio will never be less than 2.5 to 1. Upon old bricks, it will be interesting to make a 2 parts sand and 1 part NHL 3.5 mortar. Whereas concerning new bricks, a 2.5 to 1 part NHL 5 mortar is necessary.



The dash coat is made for gripping the wall up the next coats.

5.2.2.b Hemp:

Used from ancient times for the quality of its fibre, hemp can act as reinforcement and also provide insulation within the plaster.

If you wish to use hemp, you could use an NHL 3.5 in the following ratio :

4 parts lime, 2 parts sand and 10 parts hemp. Add water until you get a kind of mortar that is easy to apply.

Do not hesitate to let some air in between the hemp fibres since air is the best insulating material known.

Frost can seriously damage the scratch coat made with hemp: the air captured in the fibres can also contain some water, which when frozen, cracks the plaster surface of the wall.

To cover the scratch coat plaster, you have got the choice between several methods of finish

5.3 Finish :

Tatio board for finishings

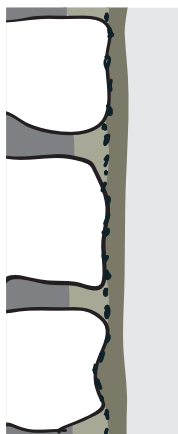
	Zone A NHL 2	Zone B NHL 3.5	Zone C NHL 5
Repointing	<i>2,5S/1C</i>	<i>2,5S 1C</i>	<i>2,5S/1C</i>
Scratch finish Timber float finish	<i>3S/1C</i>	<i>3S/1C</i>	<i>3S/1C</i>
French float finish	<i>3,5S/1C</i>	<i>3,5S/1C</i>	<i>3,5S/1C</i>

S sand for the part of Sand and **C** stands for the part of Lime.

Zone A = Zone of temperate climate

Zone B = Zone of moist climat

Zone C = Zone of very corrosive climate, seaside house, mountain, high frost



The scratch coat is made for consolidating the masonry before the finish coat.

5.3.1 Rough finish :

Shields against bad weather, the finish you choose will give your house its external charm.

Throw up the mortar on the wall.



5.3.1.1 Spanish and Rustic finish :

5.3.1.1.a Spanish finish :

The Spanish finish (1 bag of 25 kg for 5 yards square)

The Spanish finish's characteristic rests in the plastering of the whole wall, the facade, below the lintel and the window boards.

The whole stone is plaster-covered, this confers a mediterranean touch because, and it is a one-piece plaster with a rounded finish to openings such as windows.

5.3.1.1.b The Rustic finish :

Only the frontage is plastered, the door and window-frames are visible. Beware! Each frontage started must be finished in one go otherwise day joints will weaken the plasters mechanic qualities resulting in cracks and desegregation.

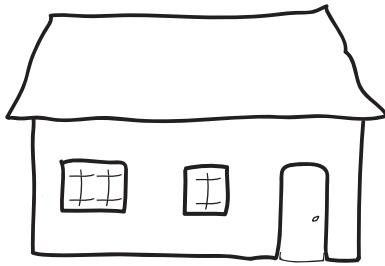
Use the NHL needed, a plaster trowel and 2 sponges will be enough to achieve a rustic finish.

The ratio generally observed is 3 parts sand to 1 part lime. Mix the sand with the lime and while the mixer is running, add slowly enough water to obtain a creamy mix.

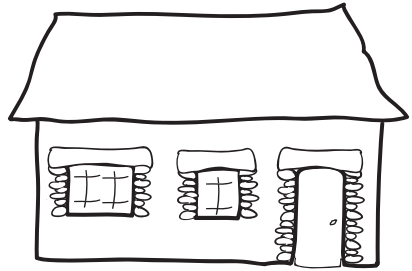
If you want to add some pigments to colour your plaster, I advise you to add to the mortar in the cement mixer two big spoons of dish washing liquid. This addition will make the pigment's dissolution easier and will prevent coloured veins from appearing in the plaster. Make some tests before starting, on small areas, to find out the right colour.

With the plaster trowel, lay the mortar in parallel coats touching each other, always from bottom to top starting from the high part of the wall. If you do it the right way, the mortar will follow the stone relief.

Once the plaster's superficial calcinations starts (the plasters superficial hardening), take a coarse clean wet sponge to take off the fine sand non-conglomerated to the plaster. Rinse the sponge out frequently.



Spanish Finish



Rustical Finish

To perfect the finish, use a soft sponge (like the sponges for washing cars) and repeat the process.

Cover-up and protect the plaster once it is dry by sprinkling some waterproof product on the wall. This will improve your plaster's durability. The operation has to be renewed every five years.

Instead of a waterproof product, you can use lime wash (please refer to Chapter 5.3.2.a Limewash).

5.3.1.2 French Float finish and wooden float finish:

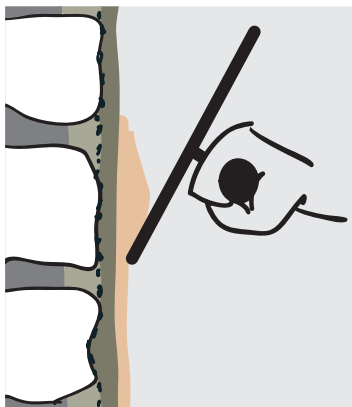
The difference between a rough finish and a finish with a float lies in the fact that while the mortar is pressed and follows the stone relief, the float gives a uniform aspect to the wall since mortar is stretched/drawn out and flattened. Use a 45° chamfered straight edge to get angles on the face and after plaster the side so that you get a 90° reinforced angle

5.3.1.3 French float

You will only need a trowel or a spray gun connected to an air-compressor, a 90 cm or 3 feet ruler and a French float.

Use the NHL needed. When you work with a French float, the ratio is 3.5 parts sand to 1 part lime.

First, lay on the mortar with the plastering trowel, a trowel or spray gun. Take care by putting on gloves. Personally I use dishwashing gloves, they protect you from dry skin and even dermatitis but don't interfere with the sense of touch.



Lay the mortar with a finishing trowel always from the bottom to the top, starting from the high part of the wall.



Frontage plaster with NHL2 and sand from PAULX quarry



Once the mortar is on the wall, take the 90cm ruler (3 feet) in your hands. Handling the ruler is really important, if you don't want too straight a wall, a small rule is best and enables you to sculpt the lime plaster.

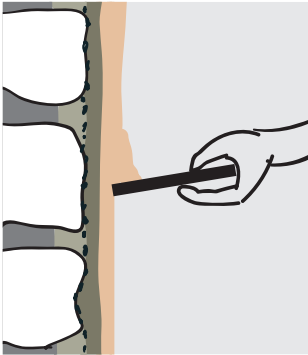
I once had to re-do plaster-work in Kilfenora cathedral (Ireland) where the scratch coat had been flattened with a 2M rule upon only one part of the wall. The other part had conserved its rounded initial form. I recreated the rounded form by sculpting the mortar on the part that had been flattened.

Wait until the mortar starts to harden before starting to float. You must finish working the frontage at one go, this will prevent you from restarting and having joints.

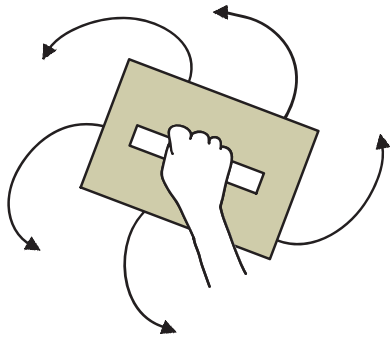
Press the plaster with the float making circles and always placing the plaster from bottom to top. The float's surface is dimpled and sucks water off the surface of the mortar, thus drying the wall's plaster and tightening up the sand's particles.

Then brush out the fine sand particles with a very flexible nylon brush so as not to scratch the plaster.

This technique I would qualify as really « French » and is the cheapest method concerning lime.



Straight edge have to be applied from the bottom to the top with slalooms.



Press the wall with the float making circles, the pressure have to be from the bottom to the top.

5.3.1.4 Normal float or used French float (1bag for 7 yards/square) :

You can also use a wooden float or normal float. In this case you will use 3 parts of sand to 1 part of lime for the mortar mix.

Since the float has not a rough surface it will have a limited ability to remove water from the mortar surface. This method is more exhausting but the result will be more aesthetic because of the visible float strokes.

Again you will brush the non-agglomerated fines out. It is interesting to work a float finish with 3S/1C ratio to produce the Tadelakt finish.

5.3.1.5 Scratch finish :

This type of finish became very popular in the 90's but since this plaster has got a smooth surface it is not self-washing and this leads to fungus and microorganism proliferation on the facade. These well-known black trails on house walls should make us realise that the work has been done too fast. Spiders also use it to nest in, causing black trails, tennis ball sized.

The administration of « Monuments Historiques » refuses this type of finish and I have advised Irish people and people from high rainfall countries against this method. Since it has no calcinations coats to protect itself, the plaster becomes « floury » with the air, and it is almost impossible to clean up.

I avoid as often as I can to use the scratch finish technique because despite being easy, it does not survive over time.

Ratio is 3 parts sand to 1 part NHL needed.

Spread out the mortar and float with a float. The morning after, just scratch the superficial coat off (calcination coat) with a special float sold in all tool retailers.

You can also take the coat off, using the edge of the float, this requires some ability.



Foam are appearing because it's a non-washable plastering finish.

5.3.1.6 Repointing finish :

This finish, the easiest, consists in filling in the joints after raking out the mortar joints. The ideal technique consists in projecting the mortar in order to fill the joints properly.

You will need a gauging trowel, a scrubbing-brush and a sponge.

I use 2.5 parts sand to 1 part lime. To know more about coloration, please refer to the pigment chapter.

If you so wish, you can also use a spray gun but take care of using a one hole small plate with only one opened hole. Replace the two nose pieces for airs projecting by blind nose pieces, just keep the one in the middle for air projecting.

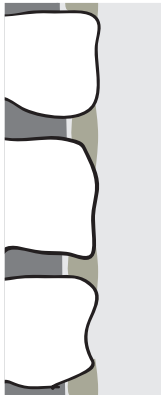
Once your pot is ready, diminish the air compression flow so that the mortar fills in the joint only, without splashing the whole stone. You can control the pressure by turning the floodgate tap on or off, directly on the compressor.

When calcination starts, brush the excess mortar off with a scrubbing-brush to let the stones appear.

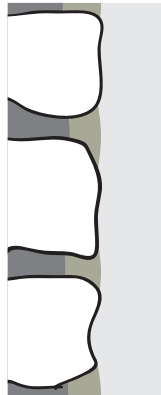
Then, wash joints with the sponge so as to make the grains uniform and to create a protective calcination coat until the mortar is completely hard.

End by cleaning the stones carefully (put gloves on!) with hydrochloric acid (30%) and water (70%) mix. Beware of splashing acid on the joints, check before if the stone on the wall is not a limestone, if it is do not use hydrochloric acid.

Repointing



Bad repointing because spaces between the new point and the masonry



Good one, no spaces between the both.

5.3.1.7 Rusticated Stone Finish :

I have been asked to make rusticated stone plasters but it does not last long since it is sold already aged (like jeans sold already aged-looking will not last as long as new ones). Consequently, a masonry contractor must employ a rusticated stone finish with precaution if it is on an external wall unless he is acquitted of responsibility by common agreement with the owner or the architect.

Spread out the NHL needed based mortar on the wall in the rustic way (please refer to chapter 5-3-1 Spanish and Rustic finishes), and then scratch fresh plaster out with a trowel or a small scratch float.

Once the excess plaster is taken off according to the way you desire the stones to be visible, make the whole plaster uniform with a sponge to produce the calcination coat again.

End by cleaning the stones carefully (put gloves on!) with the hydrochloric acid (30%) and water (70%) mix, but not extending to the plaster, check before if the stone on the wall is not a limestone, otherwise do not use hydrochloric acid.

The use of the rusticated stone finish method internally looks aesthetically well. It is nonetheless possible to use the repointing method by projecting the biggest individual stones by taking plaster off with a trowel. As for the Spanish method, pass a first sponge over the plaster and a second one to stress the stones out.



5.3.2 Smooth finish

To embellish the facade, you can perfect a rough finish by spreading a thin lime coat on.

5.3.2.1 Limewash :

Limewash is known from ancient times and is obtained by mixing 2 parts lime with 10 parts water.

The mix has to be really liquid in order to limewash the wall. Use a hair paintbrush rather than a paint-roller.

Add the content of a small wood glue bottle; its vinyl base will increase the durability of the limewash. Measure around 125 ml glue for 10 liters limewash.

You can introduce some pigments, but in this case, carry out some tests beforehand.

Limewash can be spread upon all types of finish except the scratch one and the rustic stone one. Limewash does not stick to the first one and would stain the stones of the last. Contrary to plaster, limewash is laid out like paint without adding any aggregate.

To my mind, 5 or 6 coats are needed to obtain a proper limewash. 2 parts lime to 10 parts water for the first two coats, 3 parts lime to 10 parts water for the third coat onwards.

White limewash needs to be renewed every 2 years externally at least and will last 10 years internally if no problems occur.

5.3.2.2 *Silica sand:*

Silica sand is a very fine sand produced by a mechanic process or is the result from sieving. Its diameter does not exceed 0.2mm, which allows several types of finish. It can be used on the wall inside for the very smooth lime plastering. The ratio is 1 volume of lime NHL2 for 1 volume of Silica Sand. This plaster should be put on support basically made with an NHL 3.5 or an NHL 2 but be carefully on NHL 5. This Plaster is a very thick coat about 1/8 of inch at least. It's better if you are plastering at « Fresco » that mean is when the plaster is fresh. When the plaster is on the wall, use a very soft sponge for levelling the entire surface:

5.3.2.3 *Ground finish:*

Before all else, test your ground to be sure it resists the acid chlorohydric acid (30%) and water (70%) mix

Once you have laid your tiling floor, use a mortar composed of 2 parts silica sand to 1 part lime. The hydraulicity level of the lime depends on the hardness of the tile. I generally use NHL 5.

This kind of lime will last longer if you add a damp-proof product to it. Nowadays very efficient natural ones exist.

Apply the fluid mortar in between the tiles. Get the mortar uniform and then take the excess off with a rubber rasp such as the one used for cleaning floors.

Again get the whole floor uniform with the two sponges process and end by cleaning out the floor with the acid based concoction with 30% of chlorhydric acid and 70% of water, taking care of putting gloves and mask on and beware of not touching joints. Make sure the tile is not limestone.

5.3.2.4 Wall Finish :

I work with NHL 2 to create the wall finish since it is a very white and a very fine finish. As a matter of fact it is a bit fragile but it produces an irreproachable finish on float plaster.

This ratio for the wall finish is as follows, 1.5 part silicate sand to 1 part normal sand.

The appropriated plaster support should be composed of 3 parts sand to 1 part NHL needed.

While the plaster is still damp, lay the finishing coat on carefully in order to fix the two coats together. You can spray on a water repellant for protecting your plaster.

6 - Masonry or « Limousinage »

Light Concrete Soft stone	NHL 2 <i>2,5S/IC ± 3 S/IC</i>
Hard stone	NHL 3.5 <i>3 S/IC</i>
Cold stone	NHL 5 <i>3 S/IC</i>
New brick	NHL 5 Z <i>3 S/IC</i>

S sand for the part of Sand and *C* stands for the part of Lime.

6.1 Wall masonry:

6.1.1 Soft stone masonry:

The ratio for the mortar is as follows, 2.5 to 3 parts sand to 1 part NHL 2.

Put the stone on the mortar bed and finish the exterior joints by pointing as the work proceeds.

6.1.2 Masonry using hard stones :

The ratio for mortar is as follows, 3 parts sand to 1 part NHL 3.5

Contrary to cement, lime also plays a wedging part: stones are not stuck together but wedged thanks to their own weight, the wall can breathe freely.

Joints are squeezed which apart from the resulting mechanical qualities adds an old charm to your wall, as it has always been the case with « Limousinage » masonry.

I have also met people using this technique when I was in Ireland in 1997, such as Mr Patrick McAfee, «<http://irishstonewalls.com/>» who taught me for one year the drystone masonry (laying stones without mortar). Ireland has thousands of kilometres of dry stones walls, and I had the huge honour to be turned out by one the most proficient/competent person in this field. Mr Patrick McAfee is also the person who enabled me to teach people how to restore Irish cathedrals, because if our common competence field is masonry, he is specialised in stone masonry and I am in plastering.

6.1.3 Very Hard stone masonry:

The mortar ratio for hard stone masonry is as follows, 3 parts sand to 1 part NHL 5.

6.1.4 New brick masonry:

For mechanical reasons, I prefer to use NHL 5 and cement. Let's not forget that a roof requires attention and that people will be living under this roof, so we must not make a mistake.

The ratio for mortar is as follows, 3 parts sand with 2/3 lime with 1/3 cement.

Concerning the method, it depends (once again) on the material, the brick you have chosen. If you want to place 5.5 cm*11 cm*22 cm bricks, you will have to double them to have a laying size of at least 22 cm. You can resort to bricks called "Monomur", they do not need to be doubled and are thick enough to dispense with the need for insulation.

6.1.5 Stone Replacement Technique :

This technique is particularly appropriate to the removal and replacement of soft stones.

After having removed with precaution the old stone, slide in the new stone on its new mortar bed. Point the outside of the stone up to the top leaving the horizontal top bed open.

Inject a very fluid mortar using a pipe in to the top bed, filling all the voids behind the stone. This mortar is called grout it will fill all spaces between the dressed stones and the support wall. Finish pointing the top joint.

The grout is made of 1.5 part sand to 1 part lime; use an NHL for the soft stones NHL 3.5 for hard stones NHL 5 for the very hard stones and the cold stones.

6.2 Ground masonry:

6.2.1 Lime concrete:

It was used at the time of Julius Caesar for building viaducts and others constructions but has been forgotten since the advent of cement.

Lime concrete lets material situated below and above to breathe, providing that it is not too thick (not more than 10 cm or 4 inches)

The lime concrete floor is used for the placement of terra-cotta tile for example.

The lime concrete ratio is 2 parts gravel, 1.5 part sand and 1.5 parts NHL 5.

You will need a level, a 2 metres long rule and a trowel.

Determine a point on the floor that is the finished concrete surface. Apply mortar in this place and put a piece of tile on the mortar. From this point you can use the level and rule to establish other fixed points. Stick a level on the straight edge to have a 2 metres long level.

Once you have got the first point established in this way, establish 3 other points in the same way. Linked together 2 by 2, these points help you to create paths that will guide you for applying lime concrete.

Repeat the process as many times as you need to be sure your floor is level and in range.

6.2.2 Coping:

Ratio board for coping

Soft stone Thin tilling	NHL 2 <i>3 S/IC</i>
Hard stone Terra cuta tile	NHL 3.5 <i>3 S/IC</i>
Hard stones Grès céramiques Marble	NHL 5 <i>3 S/IC</i>

S sand for the part of Sand and **C** stands for the part of Lime.

The coping is the regulation coat that allows the placement of a revetment (terra-cotta tile or whatever you choose). This coping is composed of 3 parts sand to 1 parts NHL.

Beware of pouring too much water that could weaken the coping. Create raised narrow screeds in squares with your coping mortar.

Then, powder the coping mortars with pure NHL needed while the mortar is still wet and glue the revetment up. This is a « Fresco method ».

7 - CLAY MASONRY : « PISÉ » AND « TORCHIS » (COB)

7.1 *Pisé*:

This is a rudimentary technique where clay is mixed with branches for construction.

7.2 « *Torchis* » (*Cob*):

This rudimentary technique uses rich soil with straw. This plaster put upon the earth construction will form a protective coat from bad weather.

In south Brittany (a French region with a high rainfall rate), pisé is still in use and helps efficiently to protect the walls from rain.

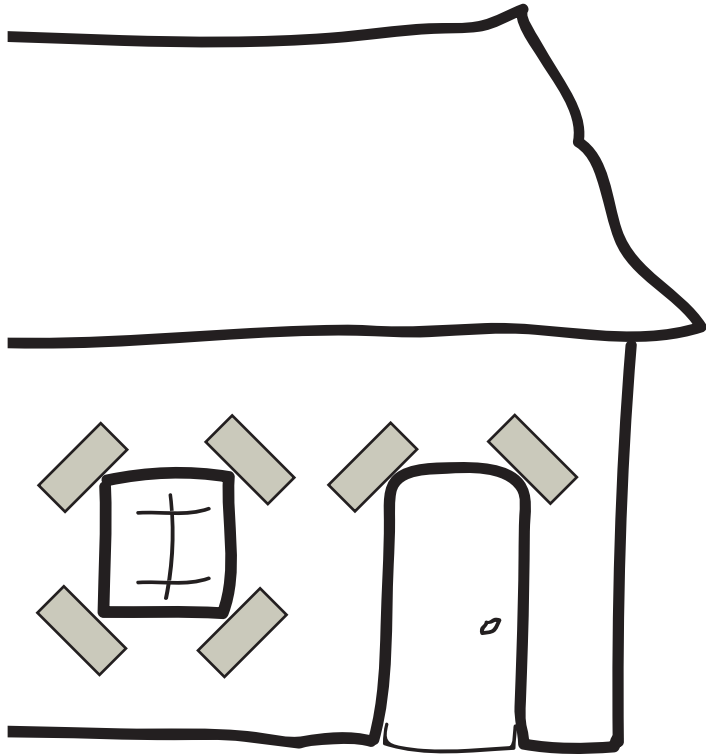
As Pisé and Torchis structures really need to breath, I recommend you to use a plaster applied with the edge of the trowel, without a scratch coat but using instead 1.5 parts sand with 1 part NHL 3.5 dash coat.

Before applying the dash coat to fix the cob's surface, spread some limewash diluted with 30% of NHL 3.5.

The finishing coat should be composed of 3 parts sand with 1 part NHL 2. Brush on in addition to the plaster some fibre glass frame aslant at 45° in order to strengthen the angles, the most fragile parts of this kind of masonry.

Spread the finishing coat with the edge of the trowel (please refer to chapter V-3-1-1 Spanish finish).

You can also have recourse to the wooden float technique (please refer to Chapter V-3-1-d).



Fiber glass is put at 45° at every angle frame.

7.3 *The double lime bending*

This masonry system was very common throughout the world for rural building in the XVIIIth century, in a time when lime was not readily available and transport facilities were not so easy (there was no road transport as we know it, of course!). As there was little lime available and it was expensive, houses were built with stones and earth/mud only and plastered with lime.

On this type of construction, strip off has to be light because it can be critical for the fragile construction. Indeed, the stones involved are stones of the surroundings (the local ones), which are then rough-casted with mud.

The rustic method must be used in this case, precociously anyway.

Wet the wall the day before with a soft jet of water. Too much water will wash away mud and stones and cause cracks to occur.

Thus, do not over wet. Mix 2.5 parts sand with 1 part NHL 2 and repoint the wall before applying the plaster.

Wait for 5 days and then, plaster with a rustic or other finish.

8 - LIME AND WOOD

8.1 - *Animal's hair*:

This plaster is used principally for lattice of chestnut wood, for the making of chestnut-wood shingle-board.

Cover the partition with 2.5 parts sand to 1 part NHL 3.5

Introduce animal hair to the mortar according to the following ratio 1 kg hair to 10 litres of lime.

Animal hair reinforces the plaster allowing it to adhere between the laths. You have made a dash coat, now make the finish you desire.

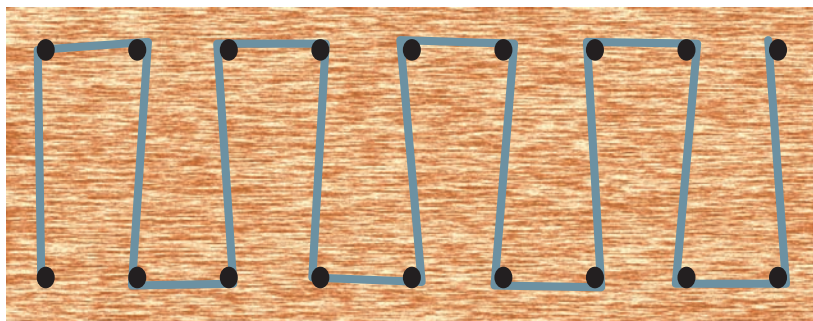
This method with animal hair is perfectly adapted to lathed ceilings in old houses.

8.2 *plastering a wooden piece:*

Use a stainless wire and interlace between small diameter non-ferrous fixings. Try to make a serpentine; this helps the plaster to grip on to the wooden piece.

Make a mortar according to the following ratio 2 part sand and 1 part NHL 2.

Apply the desired finishing coat.



Stainless wired around stainless nails.

9 -LIME AND GYPSUM:

For purists, I take a risk of talking openly in this chapter, but since it is a recurrent question, I have to say “Yes”, you can apply a lime plaster on gypsum or on an internal gypsum partition.

To this purpose, you will need:

- Bituminous steam repellant
- Stainless steel frame

First, make sure the support is clean and firm enough to support the plaster.

Clip the steam repellant upon the plaster creating covering bands of 5 cm at least or 2 inches

Then adjust stainless steel frames on the whole surface that has to be recovered, plaster with NHL 5.

You can choose the finish.

Conclusion

Cracks can develop while the plaster is drying. These are not due to the plaster itself or to something you have forgotten to do. During the drying stage (this step is as important as the application) the plaster has to be wet if the ambient temperature is over 80° F or 25° C and if it is in the inner house, beware of switching off the radiators.

Thanks

I achieved writing this accurate thanks to my father, plaster mason, master craftsman, who transmitted his art to me. I will never have enough recognition for this gift. But I also dedicate this accurate to the people that gave me the taste of making things in the right way. They confirmed that my profession was an art « in situ » and not a mere profession, because all the other corporations lie on our work.

I want to thank Fabrice Coudert fcoudert@gmx.net for having initiated me to LINUX, « open office » and « le Gimp ».

I want to thank all the people that helped and supported me, especially the correctors that guided me so that this accurate could be achieved : Juju of the Terrain Neutre Theatre and its whole team, all the Nantes Jean Jaurès street restaurateurs (Mooltypass, le Coin des Crêpes, l'Auvergnat of the Théâtre café for his patience and his good meals) without forgetting the shop of the 4 Jean Jaurès street and his owner Fab, Fred for his Tadelakt finish of which I knew only the name, the GooBar with Goobi an old friend of mine, Marc Alibert Architect from the French Heritage, and many other people whose names I think about (but I don not write).

A book written and realized by :

Olivier Labesse, mason plater.

Photos : Olivier Labesse.

Illustration and layout : Rui Manuel Mascate, rmpm.net.

Translation : anne-sophie.aboke@wanadoo.fr

And «Bethan Morgan» morganbethan@hotmail.com

Nantes 2005