



HAL
open science

GYPSUM EXTERNAL RENDERINGS OF PARIS: HISTORY AND FABRICATION

Tiffanie Le Dantec

► **To cite this version:**

Tiffanie Le Dantec. GYPSUM EXTERNAL RENDERINGS OF PARIS: HISTORY AND FABRICATION. Further Studies in the History of Construction: Proceedings of the Third Conference of the Construction History Society, 2016, 978-0-9928751-2-1. <hal-01611366>

HAL Id: hal-01611366

<https://hal.science/hal-01611366v1>

Submitted on 9 Oct 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

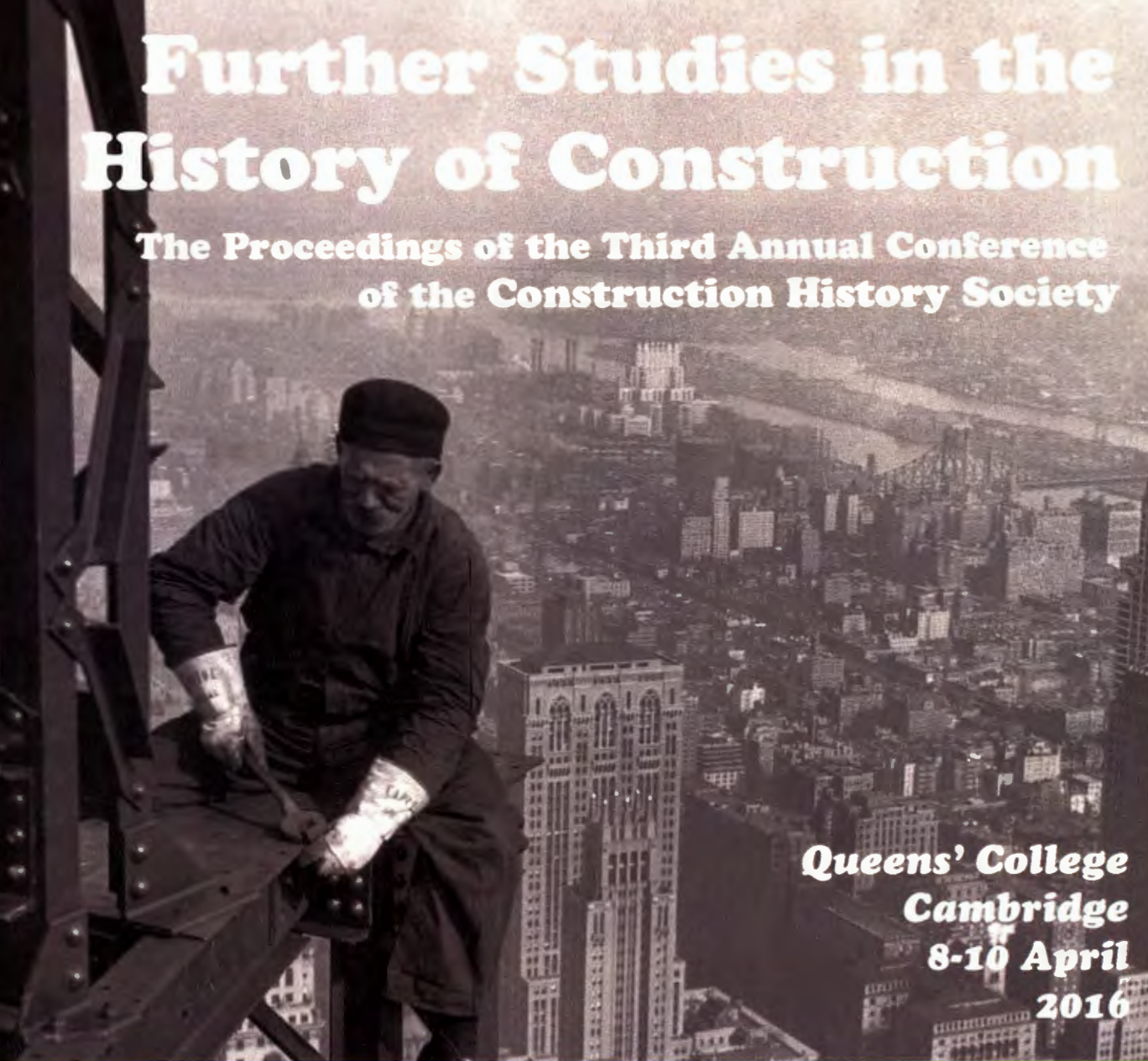
L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Further Studies in the History of Construction

The Proceedings of the Third Annual Conference
of the Construction History Society



*Queens' College
Cambridge
8-10 April
2016*

**Edited by
James W P Campbell
Nicholas Bill
Michael Driver
Michael Heaton
Yiting Pan
Michael Tutton
Christine Wall
David Yeomans**

Published by The Construction History Society
1 Scroope Terrace
Cambridge
CB2 1PX

www.construction.co.uk

© 2016, First Edition
ISBN 978-0-9928751-2-1

Copyright © by the Construction History Society
All rights reserved. These proceedings may not be reproduced. In whole or in part, in any form
without permission from the Construction History Society

Formatting and layout by Yiting Pan
First printed by Lulu print on demand for the Construction History Society

Proceedings of the Third Construction History Society Conference
edited by James W P Campbell, Nina Baker, Nicholas Bill, Michael Driver, Michael Heaton, Yiting
Pan, Michael Tutton, Christine Wall and David Yeomans

THE THIRD ANNUAL CONSTRUCTION HISTORY SOCIETY CONFERENCE

Organised by:

The Construction History Society

Hosted by:

Queens' College, University of Cambridge
&
The Department of Architecture, University of Cambridge

Organising Committee

Chair: James Campbell

Michael Heaton
Jonathan Lee
Yiting Pan
David Yeomans

Scientific Committee

Chair: David Yeomans

Antonio Becchi
James Campbell
Simon Pepper
Robert Thorne
Christine Wall

Editorial Committee

Chair: James W P Campbell

Nina Baker
Nicholas Bill
Michael Driver
Michael Heaton
Yiting Pan
Michael Tutton
Christine Wall
David Yeomans

Gypsum external renders of Paris: history and fabrication

Tiffanie Le Dantec

Laboratoire de l'école d'Architecture de Versailles /Laboratoire de Recherche des Monuments Historiques, Université Versailles-Saint-Quentin. Paris

Introduction

A research programme started in 2015 within the *Laboratoire de Recherche des Monuments Historiques* (LRMH) aimed at a better understanding of a very common material found on the facades of historical buildings in Paris and its surroundings: gypsum renders. The research programme aims on one hand to establish the true materiality of gypsum renders and find a way to replicate it or to repair it better; and on the other hand, it aims for a better understanding of the history of these renders and of the design of the Parisian facades.

The gypsum external renders of Paris are well known by the architects carrying out their restoration and by the city administration working on their conservation. However, nobody agrees on the composition of these ancient gypsum plasters, leading to numerous pathologies after ill-carried restorations. What everyone agrees on, however, is the general strength of this old material to resist weather erosion. Some renders are centuries old when restoration work begins.

Why were these traditional renders so resilient? Was it the way the gypsum was produced? Was it the way masons used gypsum on the facade? Was it the way the facade was designed? Or was it a combination of all those reasons? This article will shed some light on these questions.

To write this article, historic written literature was compared with a corpus of facades with gypsum renders and numerous visits of ruined buildings and restoration work. A geographical and historical review will set the context first. Then fabrication of 'Plaster of Paris', its application and architectonic details will be analysed to clear up the mystery of its strength.

Geography: the gypsum area

There are two main areas in France where gypsum is found easily, close to the surface and ready to be extracted: the regions of Paris and Provence. Those two regions have a built heritage of gypsum elements, mortars and internal or external renders from the Gallo-Roman period until the beginning of the twentieth century.

In the region of Paris, the use of gypsum in construction is linked to the accessibility of the raw material, easier to reach in the northern part thanks to outcrops, the most famous of them being Montmartre and Belleville, where gypsum has been extracted since the first centuries A.D[1]. Far from following the boundaries of the administrative region of Ile-de-France, the area of gypsum use can be obtained (Fig.1) by looking at built heritage

Gypsum external renders of Paris: history and fabrication

and vernacular architecture past and present[2]. In culturally distinct areas with a strong local tradition of building with gypsum - such as Parisis, Goële, Multien, Orxois and Brie Française - gypsum outcrops widely.

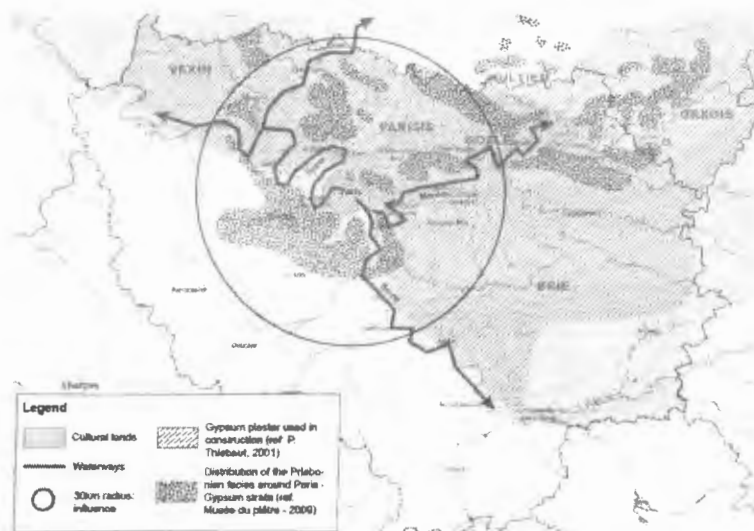


Figure 1: the gypsum area around Paris (Tiffanie Le Dantec, 2016)

The region's three major rivers, Seine, Oise and Marne, were also convenient for spreading the use of gypsum in construction. Historical urban centres with gypsum facades are a common sight all along their banks as far as Rouen, for the river Seine, where the historical city centre features gypsum-rendered facades. Furthermore, the sphere of influence of, for instance, Paris through the exporting of gypsum along carriageways from Montmartre is likely to have been the radius of around thirty kilometres around the city that could be covered by horse carriages within a day.

History of gypsum in architecture

Antiquity, from the first to the third century A.D.: prefabrication.

Gypsum was used for construction as far back as the first century A.D: roof and wall tiles, bricks and ornamental elements have been found during archaeological excavations in the location of Gallo-Roman Lutecia[3] (5th arrondissement of Paris). These were prefabricated elements, but according to the Greek author Theophrastus ('On Stones') and the Roman author Pliny the Elder ('Natural History, XXXVI Books'), gypsum renders were common in the Roman Empire, at least for internal finishes.

Middle Ages, from the fifth to the thirteenth century A.D.: new materials

The barbarian invasions were a period of intense migrations throughout Europe. The new Frankish population brought its own techniques for building: timberstructure with cob on wooden lattices[4]. The Roman stone and gypsum masonry faded into history as the Roman Empire collapsed.

Middle Ages, from the thirteenth to the sixteenth century A.D.: gypsum renderings

The use of gypsum rendering instead of cob on wooden lattices started, in France, around the thirteenth century. Several reasons are proposed for the change. The urban densification of the left bank of the river Seine covered up the extraction sites for stones, mud and sand originally located there. At the same time, the growth of the city on the right bank and its extension to the North made the construction sites closer to gypsum quarries and production areas[5]. Gypsum was then chosen for its proximity to the new parts of the city.

A contemporaneous scholar, Bartholomew The Englishman, testified the wide use of gypsum in Paris in 1372: « ... où est le plâtre en grand foison, lequel est comme verre quand il est cru, et dur comme pierre. Et quand il est cuit et détrempé d'eau, il se convertit en cyment, dont on fait les parois des beaux édifices et les parrements des maisons »[6]. (“...where gypsum is plentiful, behaving like glass when raw and as hard as a stone. And when it is baked and soaked into water, it converts to cement, from which we make the walls of the beautiful buildings and the facing of the houses.” Translation, Le Dantec)

1667: King Louis XIV's order

In 1666, the Great Fire engulfed the wooden city of London, destroying most of it. Louis XIV feared the same would happen to Paris as most of the buildings were still composed of timber structures. In 1667, the 18th of august, the King ordered that all buildings must be covered with gypsum plaster, on the inside and on the outside, to prevent fire. The same law forbade corbelled constructions and gave a maximum height for facades. Owners not obeying would face fines and the destruction of their house. Thanks to this, Paris did not burn and the Golden Age of gypsum renderings began.

Sixteenth and seventeenth centuries: the golden age

Following 1667, the city covered itself up with gypsum. Paris was then the largest and most populated city of the western world, experiencing huge urban growth and much construction. Contemporaneous authors spoke of a city where 15 out of 16 houses had gypsum facades[7], and where three quarters of the *hôtels particuliers* were also made of gypsum, encompassing a wide band of the social strata. The use of gypsum was not only for external and internal renders, but also for mortar, filling of half-timbering structures, filling of timber partition walls, chimney ducts and stacks, floor slabs, stairs and ornaments.

The use of gypsum in every elements of construction in Paris was widely described by authors from the seventeenth century until the nineteenth century:

“Le plâtre est si utile et si employé dans la construction de nos maisons, que, par l'éclatante blancheur dont il les revêt, il fait de Paris une ville de plâtre. C'est à cette matière froide qui brave les atteintes de la flamme que notre cité doit sa tranquillité contre les accidents du feu.”

Raoul Boutrays, Lutetia, 1611

Gypsum external renders of Paris: history and fabrication

(“Gypsum is so useful and so much used in the construction of our homes; its dazzling whiteness adorns them and makes Paris a city of gypsum. To this cold matter defying the wrath of the flames, our city owes its quietness against fire accidents.” Translation, Le Dantec)

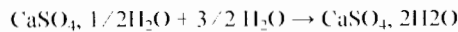
« À Paris et dans ses environs on en fait une immense consommation pour construire les maisons. (...) de manière qu'un bâtiment, depuis le sol du rez-de-chaussée jusqu'au grenier, peut être entièrement recouvert de plâtre, et paraître composé d'une seule pièce de cette matière. »

J. Claudel et L. Laroque, *Pratique de l'Art de Construire*, 1850, p77

(“There is such a huge consumption [of gypsum] in Paris and its surroundings to build houses ... that a single building, from the ground floor to the attic, might be covered with gypsum, and seems to be made by a single piece of this material.” Translation, Le Dantec)

Nineteenth century: industrialization

The first scientific investigations of gypsum were of Antoine Lavoisier during the eighteenth century, then Henri Le Châtelier during the nineteenth century. They helped develop understanding of processes such as the calcining of gypsum, the mixing, and the setting. Lavoisier wrote the formula of plaster hydration, a process known as mixing[8] :



(Plaster powder) (Water) (Gypsum)

A better understanding of gypsum, led to a more efficient way to produce it. The first machines to grind it and calcine it were designed as soon as the end of the eighteenth century to produce a thinner powder, a whiter product. The first furnaces and grinder were used in the middle of the nineteenth century and largely spread in factories by the beginning of the twentieth century. Industrialization of the sector followed the galloping urbanization of Paris and its suburbs, with a higher demand for gypsum for everyday construction. An author compares production of plaster during the nineteenth century with the production of bread: *‘le plâtre n’est pas, à Paris, sans analogie avec le pain. Paris a besoin chaque matin, de sa ration de plâtre frais.’* [9]

(“In Paris, gypsum plaster is not without comparison with bread. Every morning, Paris needs its fresh bread supply.” Translation, Le Dantec)

These new ways of production and use of machines slowly changed the materiality of the powder (Fig.2).

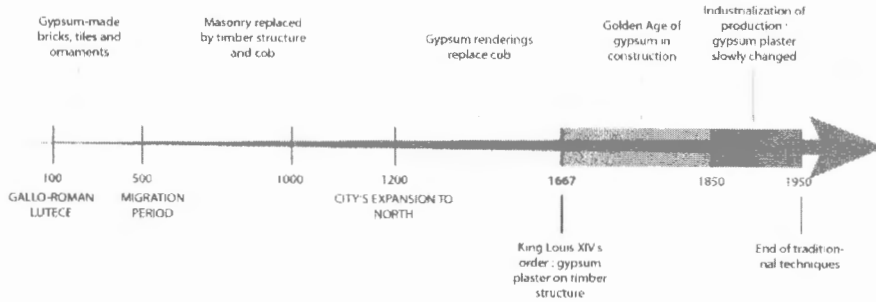


Figure 2: Timeline, history of gypsum around Paris (Tiffanie Le Dantec, 2016)

Twentieth century: crisis

Before the First World War, France was the principal exporter of gypsum and the principal producer. The quality of the “Plaster of Paris” was known worldwide[10]. After the war, gypsum in France did not adapt to the new market of building construction. The building construction required less competent workers, less ornaments, a better pace... The mason of Paris, a highly skilled worker, was suddenly not useful anymore and was replaced by migrant workers between the two wars. The masons tried[11] to change their material by using additives to slow the setting down and to increase its resilience but these chemicals were not monitored and very often led to the ruining of the facades. Architects and engineers no longer trusted gypsum plaster and stopped using it in construction.

The job evolved to become a single-tasked one, making the internal rendering of apartments became the daily life of plasterers. This job was exhausting and often subject to mockery as it was dirty and dusty, workers coughed and their body ended up crooked by the repeated contortions necessary for plastering ceilings. There is a song by Cavanna in the 1930's that goes: “*C'est le bon plâtre de paris, Qu'a fait crever mon mari*” (“The good plaster of Paris caused my husband's death.” Translation, Le Dantec).

From then until now, gypsum plaster has had a bad reputation and being a plasterer no longer attracted young people. Gypsum evolved and became plasterboard in the 1960's, relegating wet gypsum plaster to restoration works.

Traditional making of Plaster of Paris

Plaster of Paris is a product obtained after calcination of gypsum stones in furnaces. The making of Plaster of Paris follows five steps: extraction, calcination, grinding, transportation and storage.

This article focuses on the timeline between 1667 and 1950 as traditional ways of producing plaster of Paris carried on quite late. The steps described below testify to skills existing centuries before 1667 which slowly evolved during industrialization from the 1850's until the 1950's.

Gypsum external renders of Paris: history and fabrication

Extraction

Gypsum is a common mineral, calcium sulphate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), found in four strata within sedimentary rocks in the Paris Basin. The three first strata are reachable thanks to outcrops shaped as hills: Montmartre, Belleville, Chaumont, Ménilmontant, and Charonne. Extraction of gypsum blocks was done in open-cast (Fig.3) or underground excavations. It is worth noting that any owner with gypsum outcrop located in his lot could extract it and sell it in his own name[12]. The owners of quarries were then found in any social group from peasants and craftsmen to merchants and noblemen and any institution. Gypsum was found easily and did not need any particular equipment to be extracted and sold. This explains why a map of past quarries has never been done, some quarries being just a hole in the ground.



Figure 3: Quarries around Montmartre Hill (Paris en 1672 : fac-similé du premier plan de Jouvin de Rochefort, impr. Ch. Chardon aîné, 1870, Bibliothèque nationale de France, département Cartes et plans, GESH18PF37DIV3P60)

Roughly-cut blocks were extracted by the quarry workers and taken to the furnaces. Depending on historians and centuries, furnaces were located on the site of the quarry or on the construction site. Transportation of calcined gypsum from the quarry to the construction site could alter the material, so building workers preferred to heat it in the city. On the other hand the smoke was irritating and many complaints pushed the city to forbid furnaces[13] several times in its history.

Calcination

Gypsum stones must be heated to a temperature of 130°C so the calcination process occurs:



(Gypsum) (1, 5 water) (Plaster of Paris)

This low temperature, compared to calcination of lime (800°C), makes producing plaster easier.

From the eighteenth century[14] to the 1950's, a type of furnace called *four culée* was used to heat gypsum. The simplicity of these furnaces and their similarity with brick furnaces used by the fourteenth century[15] may let us think that they were used at the end of the Middle-Ages but we lack evidence. The stones were placed in a shed composed of three walls often made of gypsum stones and mortar with a high open gabled tiled roof. The stones were laid from the biggest to the smallest of top, in rows divided by vaulted holes where wood would be burned. (Fig.4). The heating process lasted around 12 hours: the stones became white as the water evaporated producing a thick smoke. Once cold, the furnace is destroyed and the stones put aside to be ground.

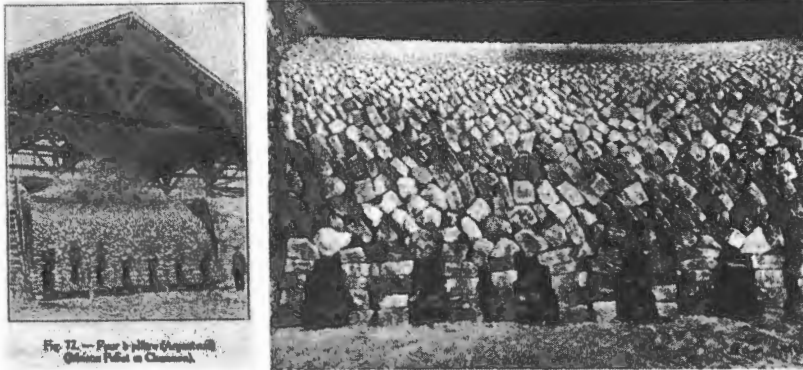


Fig. 72. — Four à plâtre (Argenteuil)
(Maison Patat et Chassagnat)

Figure 4: Traditional furnace and details of the layout of gypsum blocks. Left: *Four à plâtre* (Argenteuil), Paris, Hachette, 1932. Right: A gypsum furnace, Noisy-le-Sec, 1925, Photo Auguste Robin, Larousse, 1925.

Grinding

Traditionally, since Theophrastus to the beginning of the nineteenth century, grinding was done with a wooden staff, hitting the calcined gypsum blocks for hours, hence the still in use expression: *battre comme plâtre* (being beaten very hard). This exhausting job changed during the nineteenth century with the use of the animal-powered and then mechanical grinder, which made a much finer powder. Masons would complain as soon as the 1850s' saying that plaster came to the building site too fine and not suitable for construction[16].

Storage and transportation

Plaster produced on the quarry ended up as a rough white powder. Calcined gypsum spontaneously hydrates itself using the moisture in the air. Once calcined and ground it should be used within few days or it is called *éventé* (stale) and unsuitable for building. It can be stored in sealed barrels and moved with carriages but this way of transportation must not have been protective enough as gypsum plaster was not exported very far. Un-burnt stones were also exported to be heated where needed, but workers there lacked the skills to burn them well to make a good plaster and this solution did not lead to exportation either.

What is Plaster of Paris?

According to the different steps we have just followed, we have a clear definition of what Plaster of Paris powder comprises:.

Gypsum external renders of Paris: history and fabrication

- Gypsum : in at least four different forms according to the temperature the stones were at and their proximity to the flames :
 - Underburnt gypsum (< 130°C)
 - Hemihydrate α and β (130-150°)
 - Overburnt
 - Anhydrite III (200°C)
 - Anhydrite II (220-350°C)
- Calcium carbonate: resulting from of having sedimentary rocks (limestones) extracted at the same time as gypsum. Quarries had different amount of calcium carbonate in the gypsum strata, from 3 to 13% (Table.1).
- Coal and ashes: resulting from the burning of wood. Workers testified that replacing wood by coal or bituminous coal did not provide a plaster suitable for construction.
- Quartz and silica: resulting from dusty quarries, and beating on the ground... A wealthy owner[17] of quarries as soon as the eighteenth century complained that the dirtiness of his quarries and his workers would spoil the gypsum plaster.
- Lime perhaps, if the temperature in the furnace reached 800°C.

Different studies were done as early as the nineteenth century (Table.1) and more recently to clearly say what gypsum plaster comprises. The studies agree on saying that there is between 4 and 20% of calcium carbonate, a bit of quartz (not always), a bit of silica, some oxides, pieces of coals (Fig.5) and the rest is gypsum.

Table 1: Gypsum plaster exhibited at the 1878 Exposition universelle in Paris. In. Gustave Oslet. Cours de construction. Matériaux de construction et leur emploi. Paris. 1885. Archives du Musée du Plâtre

Name of the gypsum plaster	Calcium sulphate %	Calcium carbonate %	Magnesium carbonate %	Aluminium oxide and ferrous peroxide	Insoluble %	Water %	Observations
Vitry	79.9	10.2	8.93	2.5	4.9	4.43	normal
Vitry	72.6	12	5.43	2.7	3.7	3.53	fine
Romainville	87.7	2.4	2.7	0.5	0.6	5.5	normal
Villejuif	77.95	8.5	1.9	6.6	4.8	6.25	normal
Bondy	79.05	9.9	2.3	1.5	4.4	5.53	normal
Bondy	83.4	6.9	2.3	1	2.4	4	fine
B-Le Centre	83.75	4.5	0	0.35	1.2	5.4	normal
Lamarche	85.45	3.75	0	0	1.6	6.2	normal
Bussières	84	7.15	0.4	0.45	1.05	6.9	normal
Moyenne	80.87	7.23	2.23	1.1	2.74	5.71	

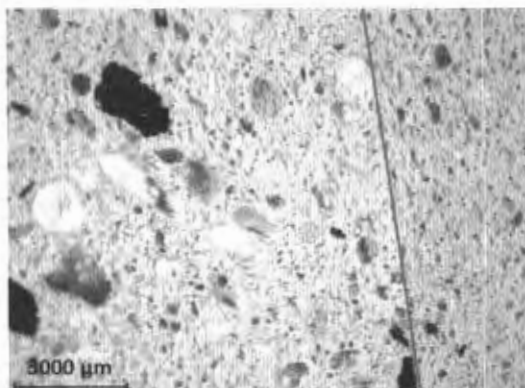


Figure 5: Two layers of rendering, charcoals and unburnt gypsum can be seen on left. *Théâtre de la Renaissance, Paris*. Binocular macroscope. (photography Jean Ducasse-Lapeyrusse, LRMH, 2015)

We also can conclude that plaster of Paris was a very rough powder, barely a powder at all judging by comments from nineteenth century masons who had to beat the plaster into pieces again on the construction site[18].

It is important to mention here that lime-based mortars were also used at the time in construction, but gypsum mortars were used even more in vernacular architecture. The prices for lime-based or gypsum-based plaster were roughly the same according to treatises from eighteenth century, but as gypsum mortar would have a quicker setting time, workers would choose it. Concerning renders, there are only gypsum-based renders in the region of Paris; there never were lime-based renders.

Traditional application of gypsum external renders

Masons and plasterers feature in the book by Etienne Boileau[19] describing all the statuses of professions in Paris from 1254 to 1271. Plasterers were the workers extracting and heating gypsum while the gypsum plaster was used by masons. A hierarchy of apprentice, companion and master masons used it to build an entire building from scratch.

Material preparation

Vocabulary of gypsum plasters : grinding and screening on site

The masons used gypsum plaster straight out of the barrel or jute bag. They screened it using two different sieves: a basket producing *plâtre au panier* (basket plaster) and a horsehair sieve called *sas* and producing *plâtre au sas* (horsehair sieve plaster). The basket had larger holes than the horsehair sieve and produced a rougher gypsum plaster.

Workers could also make a thinner plaster throwing gypsum plaster in the air with a spade: the layer of plaster stuck to the spade is called *fleur de plâtre* (flower of plaster). Another type of plaster was made putting plaster from the barrel through the basket then through the *sas*: instead of getting the thin plaster out of the last sieve, the worker will take the plaster on top of the horsehair sieve, which is called *crépis*.

Gypsum external renders of Paris: history and fabrication

Masons created the type of gypsum plaster they needed by beating the gypsum and screening it. These operations led to gypsum plasters with extremely different granularity.

Mixing plaster.

The mason gently sprinkled the gypsum powder on water until they merged and then mixed it with his trowel to obtain a paste. The amounts of water and plaster also depended on which type of paste the mason needed. Usually, a normal paste for a gypsum rendering would contain half plaster and half water. Masons put less water to have a more resilient plaster with less porosity and a quick setting: useful for joints. They put more water into the paste for pouring gypsum plaster into cracks and for some layers of renders.

Application of gypsum external renderings following treatises from the seventeenth, eighteenth and nineteenth centuries

Treatises[20] from 1691 until 1885 have been used to develop this model of traditional application of gypsum renders. This is how it was done before industrialization changed the material too much and before the knowledge of this manner of production and use disappeared. The application followed these steps:

- The wall, either made of rubble stones, bricks or timber-framed structure with stone, brick, or gypsum fillings should be brushed and soaked with water the day before the render is applied. Timber lintels and structures should be riddled with nails or grooved for a better bonding.
- Renders should never be applied in temperatures below 5°C or over 35°C, or when it rains.
- Ornamental features (mouldings) were always made before the renders were applied.
- The gypsum rendering was composed of four layers depending on the state of the wall (Fig.6):
 - *Renformi*: if in a bad state, the wall was put back in shape to insure its flatness. A compact gypsum paste was made to fill the holes and make the joints. Bumps were planed off.
 - *Gobetage*: A quite fluid gypsum paste is cast upon the wall with a wide brush, quickly the mason unified the layer with his hand. The layer is left to set.
 - *Crépi*: A quite compact paste is made with the *crépis*, the leftovers of gypsum on the top of the horschair sieve. This gypsum plaster was cast on the wall with a brush, a trowel or the hand. The layer was then unified quickly with the back of the trowel. A *Berthelée* trowel was then used to groove the layer with its toothed side.
 - *Enduit*: A more fluid paste is made for the final layer with the plaster from the horschair sieve. It was cast and spread with a trowel. Then, when the plaster set, the layer was cut with the sharp side of the *Berthelée* trowel in order for the whole wall to breathe.

Altogether, the layers can reach a thickness between 5 and 12 cm.



Figure 6: Goussainville, nineteenth century house. Left: general view. Right: detail on the layers of the rendering. (Tiffanie Le Dantec, 2015)

Each layer then had a different porosity and a different granularity. Research has still to be done to fully understand the way the layers work together to let the wall breathe: how is the moisture transfer insured from the wall to the outside but not the other way round.

Toward a gypsum architecture?

Gypsum plaster has many qualities. It is breathable; it helps moisture exchanges; it is fire-proof; and it is plastic. Its plasticity, in particular, allows it to accommodate seasonal movement of timber or stone structures. It has a good 'bounding', i.e. during setting, gypsum plaster expands and will fill all the voids and holes in the support. And it has good thermal insulation and soundproofing qualities, thanks to its porosity. But these qualities are nowadays overshadowed by a disadvantage: its solubility in water.

Features for avoiding water flow

Scientists working on the research programme will tell us in the coming years how the materiality or the application of those ancient gypsum plasters fought solubility. The design of the facade is also very important for avoiding rainwater flow over the facade. Moisture is not so much of a problem as long as it can dry. The real danger is a constant water flow slowly dissolving gypsum. Centuries of use of gypsum plaster architecture in the area of Paris have allowed masons and architects to solve the problem and led to facades being able to survive decades without damage.

In order to prevent the dissolving of the facade, some architectural features were necessary to resist water ingress:

Gypsum external renders of Paris: history and fabrication

- Rainwater flow: mouldings on the facade insured that flowing water did not wash the facade away, but encouraged formation of drops that would fall to the ground. Cornices on top, string-courses at every floor, and external window frames are part of these features.
- Water splash: when they meet a plane surface, raindrops throw other smaller raindrops around, causing dissolving of the render. This was prevented with a metal (lead or zinc) sheet over the string-courses and a different material for the base.
- Capillary rise: water from the ground rises through the foundations of the building and exits the wall, going through the mortar, joints and renderings to get out. This water is often in liquid form and cause damages to gypsum plaster.

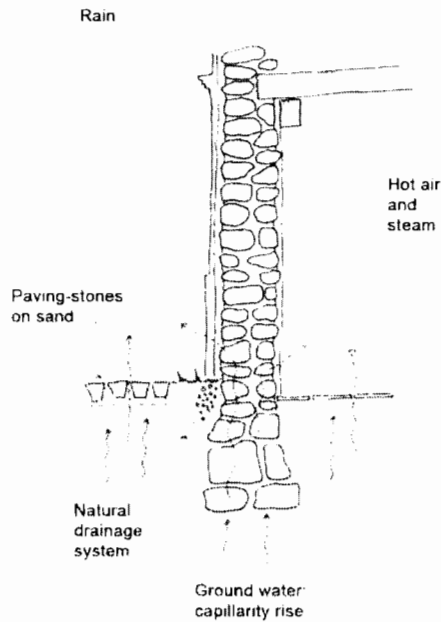


Figure 7: Cycle of water through seasons inside a stone wall with gypsum renderings (Tiffanie Le Dantec, 2015)

Conclusion

The long lost strength of gypsum external renders was certainly due to the heterogeneity of its composition, the highly skilled *savoir-faire* of the masons who knew, after five centuries practising gypsum plaster, how to make it last longer. The design of the facade, skilfully avoiding water flow on the surface of the renders also adds to what one can consider gypsum architecture.

The aim of this paper was to expose the first elements of research on the gypsum external renders of Paris. Its aim was also to ask questions, to be able to carry on research in this direction through the thesis and through the research programme led by the I.R.M.I.L.

Among many questions, the main one is: how can people trust gypsum plaster again? After 100 years of despising plasterers and having a low quality material, how can young apprentices be made willing to practise this job once again and carry on the legacy of the skilled masons of Paris?

Acknowledgements

LRMH team: Jean Ducasse-Lapeyrusse PhD, LRMH civil engineer; Véronique Vergès-Belmin, LRMH research engineer and *Pôle Pierre* responsible; Stéphanie Celle, heritage architect, LRMH deputy director.

LéaV team: Nadia Hoyet, architect, PhD supervisor

Fondation des Sciences du Patrimoine : Emmanuel Poirault, director

Evan Chakroff, architect and author.

Notes and references

- [1] Association des Géologues du Bassin parisien, «Les anciennes carrières de Paris et leur consolidation» in. *Les Roches au service de l'Homme. Géologie et préhistoire du Bassin parisien*, Bulletin d'information des Géologues du Bassin parisien, Mémoire hors-série n°7, publié avec le concours de Gaz de France, 1989, Condé-sur-Noireau
- [2] Thiébaud, P., *La maison rurale en Ile-de-France*, Eyrolles, 2001
- [3] Robin, S., Philippe Marquis, 'Aux origines du plâtre de Paris', *Le Plâtre. l'Art et la Matière*. Créaphis, 2002, p.89
- [4] Taté, T., *Historique du Plâtre, Congrès Technique International de la Maçonnerie et du Béton Armé*, 1928
- [5] Robin, S., Philippe Marquis, *op cit*, p.89
- [6] Barthélémy L'Anglais, *De proprietatibus rerum*, n.d.
- [7] Ferroussat de Castelbon, E.H., *Réflexions sur la mauvaise qualité du plâtre et sur sa cause*, Paris, 1776
- [8] Lavoisier, M., *Mémoires de Mathématiques et de Physique, présentés à l'Académie Royale des Sciences, par divers savants et lus dans les assemblées. Tome cinquième*. 1768 p.341
- [9] Canet, M.M., 'Quatre générations de plâtriers dans le nord-ouest parisien, ruptures et continuités à la plâtrière Vicujot', *Le Plâtre, l'Art et la Matière*, Créaphis, 2002, p.47-57
- [10] Gilardi, P., *Le plâtre, ses caractéristiques essentielles pour la construction*, 1933, Archives du Musée du Plâtre
- [11] Encyclopédie des Métiers, *La plâtrerie. le Staff et le Stuc*, Vol.2, Les Compagnons du Devoir, 1994
- [12] Guini-Skliar, A., *La pierre à bâtir dans l'architecture parisienne*, Tours, 1998
- [13] Le Roux, T., 'Des fours à plâtre dans Paris, Histoire d'une parenthèse conflictuelle, 1765-1800', *Les Articles du Musée du Plâtre*, 2010
- [14] Diderot et d'Alembert, *Recueil de Planches sur les Sciences, les Arts libéraux et les Arts mécaniques*, Paris, 1751-1772, Fig. 1
- [15] Lafarge, I., *Le plâtre dans la construction en Île-de-France: techniques, morphologie et économie avant l'industrialisation*, Ph.D. Thesi, Université Paris I Panthéon-Sorbonne, 2013, p613.
- [16] Claudel et Laroque, *Pratique de l'Art de Construire en Maçonnerie*, Paris, Carilian-Gocury et V. Dalmont,

1850

- [17] Ferroussat de Castelbon, E.H., *Réflexions sur la mauvaise qualité du plâtre et sur sa cause*, Paris, Lottin Aîné, 1776
- [18] Nadaud, M., *Mémoires de Léonard, ancien garçon maçon*, Paris, 1895
- [19] de Lespinasse, R., et Bonnardot, F., 1879 - *Les Métiers et corporations de la ville de Paris - XIIIe siècle, le livre des métiers d'Etienne Boileau* ; Histoire générale de Paris, Imprimerie Nationale
- [20] Treatises used to establish the traditional application of gypsum external renderings:
- de'Aviler, A.G., *Cours d'Architecture*, (Paris: N. Langlois) 1691
- Bullet, P., *Architecture Pratique*, (Paris: J.B Delespine, J-T Herissant) 1741
- Diderot, D., et D'Alembert, J le R., *Encyclopédie ou Dictionnaire raisonné des Sciences, des Arts et des Métiers, par une société de Gens de lettres*, Original edition online: <http://portail.atilf.fr/encyclopedic/>, 1765
- Patte, P., *Mémoires sur les objets les plus importants de l'architecture*, (Paris: Rozet), 1769
- Lucotte, J, R., *L'Art de la maçonnerie*, (Paris: Imprimerie de Moutard), 1783
- Rondelet, J,P., *Traité théorique et pratique de l'art de bâtir*, (Paris: Private), 1827
- Biston, V., *Manuel théorique et pratique du Chauffournier.*, (Paris: Manuel Roret), 1836
- Claudé, J., et Laroque, L., *Pratique de l'Art de Construire en Maçonnerie*, (Paris: Carilian-Gocury et V. Dalmont), 1850
- Toussaint, M., et Magnier, M.D., *Nouveau Manuel Complet du Maçon, du couvreur, du paveur*. (Paris: Manuel Roret), 1864
- Chabat, P., *Dictionnaire des termes employés dans la construction*, (Paris: Morel), 1876
- Oslet, G., *Cours de Construction, Matériaux de Construction et leur emploi*, (Paris), 1885