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978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

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A Practical and Scientific Treatise on Calcareous Mortars and Cements, Artificial and Natural

Having devised an artificial cement in 1817, Louis-Joseph Vicat (1786–1861) sought to share and further the science surrounding calcareous cements. His son, Joseph Vicat, went on to found the eponymous company which became an international manufacturer of cement. This work was first published in French in 1828 and is reissued here in the English translation of 1837. Vicat addresses the subject of limes, the ingredients used to prepare mortars and cements, and how these building materials are affected by environmental conditions, such as immersion in water or exposure to damp soil and inclement weather. He also compares binding products of the time with those developed by the ancient Egyptians, Romans and Greeks. The translator, J.T. Smith, provides helpful explanatory notes and clarifies technical terms. Charles William Pasley's *Observations on Limes, Calcareous Cements, Mortars, Stuccos, and Concrete* (1838) is also reissued in this series.

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Frontmatter

[More information](#)

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Frontmatter

[More information](#)

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LOUIS-JOSEPH VICAT
EDITED AND TRANSLATED BY
JOHN THOMAS SMITH



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Frontmatter
[More information](#)

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Cambridge University Press

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Frontmatter

[More information](#)

A
PRACTICAL AND SCIENTIFIC
TREATISE
ON CALCAREOUS
MORTARS AND CEMENTS,
ARTIFICIAL AND NATURAL;

CONTAINING,

DIRECTIONS FOR ASCERTAINING THE QUALITIES OF THE DIFFERENT INGREDIENTS, FOR
PREPARING THEM FOR USE, AND FOR COMBINING THEM TOGETHER IN THE MOST
ADVANTAGEOUS MANNER; WITH A THEORETICAL INVESTIGATION OF THEIR PROPERTIES
AND MODES OF ACTION.

THE WHOLE FOUNDED UPON AN EXTENSIVE SERIES OF ORIGINAL EXPERIMENTS,
WITH EXAMPLES OF THEIR
PRACTICAL APPLICATION ON THE LARGE SCALE.

BY L. J. VICAT,

ENGINEER IN CHIEF OF BRIDGES AND ROADS; FORMERLY PUPIL OF THE "ECOLE
POLYTECHNIQUE;" MEMBER OF THE LEGION OF HONOUR, ETC., ETC., ETC.

TRANSLATED,

WITH THE ADDITION OF EXPLANATORY NOTES, EMBRACING REMARKS UPON THE RESULTS
OF VARIOUS NEW EXPERIMENTS,

BY

CAPTAIN J. T. SMITH, MADRAS ENGINEERS, F.R.S.

ASSOCIATE MEMBER OF THE CIVIL ENGINEERS INSTITUTION, LATE PRESIDENT
OF THE EDINBURGH PHILOSOPHICAL SOCIETY.

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Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

Cambridge University Press

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Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TO

JOHN GRANT MALCOLMSON, ESQ.,

MADRAS MEDICAL ESTABLISHMENT, M.D., F.G.S., F.R.A.S.,
ETC., ETC., ETC.,

THIS WORK IS INSCRIBED,

IN TESTIMONY OF UNFEIGNED ESTEEM,

AND IN GRATEFUL ACKNOWLEDGEMENT OF NUMEROUS AND

DISINTERESTED ACTS OF REAL KINDNESS,

BY HIS OBLIGED

AND VERY SINCERE FRIEND,

J. T. SMITH.

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Frontmatter

[More information](#)

Cambridge University Press

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Artificial and Natural

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Frontmatter

[More information](#)

AUTHOR'S PREFACE.

THE art of composing calcareous cements was confined, till within the last few years, to the knowledge of a small number of facts, and to the observance of certain rules long since admitted into use without examination, on the authority of Vitruvius and the architects who followed him. But the rules were almost always found to be at fault, and the facts, for want of correlativeness, were of but little aid. Could we, for instance, manufacture good mortar in France, by mixing three parts in bulk of dry pit sand, or two of river sand, with one part of slaked lime derived from a white marble of great hardness? Such, however, are the proportions of admixture, and the characteristics of good limestone pointed out by Vitruvius. It was of little importance besides to those, to whom it was impossible to procure it, that the pouzzolana of Italy and the Dutch tarras were possessed of extraordinary binding qualities; that lime eminently adapted for hydraulic works was to be found at Metz, Viviers, Nismes, &c., in France, at Lœa in Upland, at Aberthaw in England, and elsewhere. With all this information, and even adding to it the discoveries of the Swedish Baggé, and Count Chaptal, regarding the transformation of some schists, and certain ochreous clays into pouzzolanas by calcination, it was not the less necessary to work by guess in most instances, or to trust to obscure analogies for the success of the most important works. One engineer vaunted the efficacy of the powder of *well-burnt* tile, another looked upon smithy slag and iron-dross as the finest ingredients. These again, on the other hand, asserted, that such substances are destitute of energy. Lastly, this difference of opinion extended even to the manipulation of the compounds. Was the lime to be slaked with much water, or to be allowed to fall to

A*

Cambridge University Press

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Frontmatter

[More information](#)

powder after having immersed it for a few seconds? Should it be applied hot or cold? &c. Every plan had its partisans; and what doubtless appears paradoxical was, that each method too was supported by experiments and testimony, of which it was hardly possible to dispute the authenticity.

We shall leave it to the reader to appreciate a state of things like this, and to decide whether such a chaos of opinions and opposing facts could or could not make up a science,—a doctrine of calcareous cements. Perhaps it may be replied, that at the epoch of which we speak, builders had learnt to erect bridges, locks, &c., without either tarras or pouzzolana, and in countries where the lime possessed no extraordinary quality. Without denying this truth, we must remark, that most of these works have not endured, nor can continue to endure, but by frequent and expensive repairs. That on many canals it has been necessary to reconstruct a great many locks, whose side walls were in a few years found to be quite stripped of mortar. That a multitude of dikes, sluices, weirs, (“bar-rages,”) and aqueducts, of recent construction, already exhibit all the characteristics of age, without the possibility of attributing these unexpected dilapidations to any other cause than the bad quality of the mortars or cements made use of.

These facts, known to a number of engineers, have long since attested the insufficiency of the art; and this insufficiency exhibited itself more and more, owing to the multiplicity of marine works called for by a constantly increasing commerce. It was to put an end to such a state of things, that we, in 1812, commenced our experimental researches, published in 1818. The subject, so to speak, is one of intrinsic importance, and consequently to discuss it merely is sufficient to attract public attention. We may, therefore, be allowed to say, laying aside personal vanity, that the experimental researches on lime and mortars have been the subject of serious examination by chemists, architects, and engineers. Certain theoretical points, independent of general results, have given rise to these discussions, which have themselves stimu-

Cambridge University Press

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Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

PREFACE.

iii

lated us on our part to new labours. Experiments in contrast with one another, undertaken in various parts of the kingdom by order of Mr. Becquey, Director-General of Public Roads and Mines, while they consolidated the necessary fundamental points established by us, enlarged the domain of facts to such an extent, that it became necessary to re-digest the whole, in order to arrange and compare them together. But by this very operation, owing to the multiplication and mutual support of the truths, they have added fresh confirmation to those which we were already possessed of. They have also enabled us to contract the scale comprehending them, both by leaving us at liberty to adopt a mode of classification before impossible, as well as by affording us the power of casting into notes a crowd of details and historic or scientific documents, useful to consult, but not indispensable to the understanding of the whole.

It is, moreover, in the nature of things to become more simple, in proportion as they approach perfection; and this is the more fortunate, as now-a-days, much more than formerly, large volumes create alarm, and are no longer read.

These explanations having been given, we are anxious here to make known the fresh obligations which we labour under to the analytic and synthetic labours of Messrs. John and Berthier, on calcareous compounds and hydraulic limes; to the researches of M. Bruyère, Inspector-General of Roads and Bridges, on the manufacture of artificial pouzzolanas and cements, resulting from the calcination of clays combined with a small proportion of lime; to the very remarkable experiments of Messrs. Avril and Girard de Caudemberg, Engineers, the first on the psammites of Finisterre—the second on the arenés of Perigord; to the examination of the limes of Russia by Col. Raucourt, an examination which has led that Engineer to enrich the science with numerous important observations; and lastly, to the interesting results obtained by M. Lacordaire, Engineer, in using the hydraulic limestones imperfectly burned, as natural cements.

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
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Frontmatter

[More information](#)

There are services of another kind which require no less acknowledgment—such is the generous and enlightened manner in which M. Bruyère, Inspector-General, first, in 1818, obtained for my work the attention and support of the Director-General and Council of Roads and Bridges; such also is the succour afforded to this work by the honourable mention of it which Messrs. Gay-Lussac and Thenard have been pleased to make in their Lectures in the “Ecole Polytechnique;” in the Syllabus of his Lectures on Building by M. Sgauzin, Inspector-General; and lastly, in an able Report to the Academy of Sciences, by M. Girard, Member of the Academy.

Cambridge University Press

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Frontmatter

[More information](#)

TRANSLATOR'S PREFACE.

THE merits of M. Vicat's valuable researches into the composition of mortars and cements are already too well known, to render it necessary for me to apologise for an endeavour to extend their usefulness, by submitting them to the public in a more accessible form. But as the motives which induced me to undertake this work, and have encouraged me to persevere in its fulfilment, may require explanation, I ought not to refrain from making them known, nor from claiming that indulgence for the result of my labours, which the peculiar circumstances under which they have been accomplished render necessary.

Having been occupied for many years in the construction and repairs of numerous public buildings, the charge of which devolved upon me in the performance of staff duties, I was long embarrassed, in the endeavour to give durability to works executed under my superintendence, by many difficulties arising from the defective quality of the cements employed, the dampness of the situation, and other causes at the time unknown.

Anxious to remedy these evils, I engaged in a series of experiments, in which numerous modifications of the processes previously employed, and every suggestion which could be gleaned from the scattered hints contained in the writings of the various English authors who have incidentally touched on the subject, were put to trial, both with reference to the durability of the compounds, as well as their economy on the large scale. But although these endeavours were followed by many promising results, it was not until I became pos-

a

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Artificial and Natural

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Frontmatter

[More information](#)

sessed of M. Vicat's Work, that the theory of the composition of mortars and cements was developed in a sufficiently satisfactory and comprehensive manner, to enable me to take a full view of the varied resources found within the limits of almost every locality, for the fulfilment of the objects of which I was in search. But, systematic and plain as M. Vicat's instructions and experiments are when well understood; yet it was not without much labour, in repeating many of the experiments, and the perusal of other French authors on the same subject, that I was enabled to overcome the difficulties occasioned by my imperfect acquaintance with the exact meaning of the numerous technical terms employed in it, and fully to appreciate the originality and appropriateness of the experiments, and the depth and philosophical accuracy of the reasoning founded on them. Having surmounted these obstacles, and felt the great value of the copious information placed at my disposal, I could not look back upon the pains which it had cost me to effect my object without being led to consider, that others similarly situated with myself might have the same impediments to contend with; and that I might assist future inquirers, by placing the labours of M. Vicat within the reach of those, who might not possess sufficient leisure to give that attention to his work which I had found to be indispensable.

Of the desirableness of such a work, indeed, it needed but little consideration to satisfy me; for though intimately connected as such researches are with the success and durability of our most important constructions, and with the security and domestic comforts of every class of civilized society; it is remarkable, that since the publication of Dr. Higgins, now rendered obsolete by the rapid strides which the art has taken since his time, no English work on this subject has yet appeared. Nor have the investigations connected with it, hitherto, attracted the attention of any of the distinguished philosophers, to whom science and the arts are in other respects so largely indebted.

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Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TRANSLATOR'S PREFACE.

vii

At a time, therefore, when the rapidly extending demands of a quickly progressive civilization, daily give birth to new and stupendous undertakings, there could be no doubt as to the benefits which must result from bringing before the public, the labours of those who have devoted themselves to the study of this very important and hitherto neglected branch of Architecture, and of placing within their reach the many valuable facts brought to light by them.

But of my own fitness for this undertaking, even with the advantages of expected leisure under which it was commenced, I could not avoid feeling the greatest diffidence; nor should I have ever ventured to incur so great a responsibility, had I not been encouraged by the consideration, that much which could not fail to be of service, might be effected by the mere exertion of persevering industry. And that, although, as I felt conscious, numbers might have been found infinitely better qualified than myself to do justice to the task; yet, that the very circumstance of superior fitness, joined to the increasing demands upon the talented members of the profession to whose province it would most properly belong, would be sufficient to prevent the public from ever deriving the benefit of their assistance.

Under the influence of these considerations, therefore, and in the hope of thereby finding useful and instructive occupation, for the leisure which an absence from my duties on account of ill health would afford me, I made up my mind to commence the task. But I had not proceeded far, when I was unfortunately deprived of the advantage upon which I had principally relied for success, by being called upon to apply the time I had intended to devote to this object, to the service of Government in a different pursuit; whereby I was deprived of the ability to devote that attention and study to it, which it was my earnest wish to have done.

These causes must, I fear, necessarily be pleaded as an excuse, for those inaccuracies which I cannot hope to have escaped

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Frontmatter

[More information](#)

from; and which will, I trust, be treated with indulgence. In the general design and execution of the work, however, I have not failed to keep in view the convenience of the reader, in so far as it lay in my power to add to it, or to the general usefulness of the volume. I have therefore, throughout, endeavoured to communicate whatever information it was in my power to collect, either from the published works of others, or from my own experiments, in illustration or support of the opinions or statements contained in the text. The whole of the measures made use of have, also, except when clearly unnecessary, been reduced to the corresponding English standard; a process which has also been applied to the very valuable results collected together in the Tables. Thus, these experiments now admit of a ready comparison with similar ones made in this country, and the reader will find no difficulty in forming a clear apprehension as to the efficiency of the processes to which they are applied as tests. It may be proper to add, that these calculations have been made from tables of the correspondence of English and French weights and measures, given at the end of Ure's Chemical Dictionary (Edition of 1824).

In the first, or more practical part of the volume, explanations have been given in the notes, of such scientific terms as may not be familiar to the general reader. This, however, has not been done in respect to all the notes in the Appendix; as many of them, consisting of purely scientific reasoning, could not, in the limited space of a note, have been rendered perfectly intelligible to those by whom the terms themselves were not understood.

These additions, with that of a copious Index, and a more distinct separation of the various subjects severally treated, will, I hope, materially assist the perusal; more particularly by obviating the confusion liable to be occasioned by the apparent contradiction of the different directions given in the work, applicable to various circumstances. In the latter part of the volume, I have ventured to take a liberty with respect to its

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Artificial and Natural

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Frontmatter

[More information](#)

TRANSLATOR'S PREFACE.

ix

arrangement, to which I was prompted by a desire to attract the attention of the scientific reader to a subject hitherto little noticed. I have for this purpose converted the "note on the theory of calcareous mortars and cements" into a distinct chapter (the seventeenth); to which the appendix to that note, together with the particulars of some experiments by myself in prosecution of the same subject, have formed an appropriate appendix. To this more prominent position in the body of the work, the theoretical investigations above mentioned seemed to me to be entitled, both from their close connexion with and essential influence over successful practice, as well as from their intrinsic value and philosophical interest. Its discussion is accompanied, moreover, by so many hints calculated to awaken attention and stimulate inquiry, whilst so little seems to be wanting to complete the evidence, that we may soon hope to be possessed of a sufficient number of facts, to form the basis of a correct theory of the hitherto ill-understood causes of solidification, under all the various circumstances in which it takes place.

In regard to the use of some new terms which I have found it necessary to apply, it may be right to explain, that after trying many substitutes taken from the technical language of the best authorities on this subject, I found M. Vicat's classification so different and so much more methodical than any which has hitherto obtained in this country, that I should have run the risk of sacrificing the clearness of his arrangement, had I attempted to introduce any synonymes taken from the English language to express his meaning, in lieu of the simple translation to which I have confined myself. Other words, used for the purpose of defining substances hitherto classed by us under a more general category, and consequently intended to mark distinctions at present unknown, such as "arenas," "psammites," &c., I have thought it advisable to convert at once into English terms, taking care to explain their meaning on their first application.

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Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

x

TRANSLATOR'S PREFACE.

Of the particular merits of the numerous practical instructions and varied processes contained in this volume, it would perhaps be premature in me here to speak; the most satisfactory recommendation being the experience of those, who may have occasion to put them to the test of actual trial. I ought not, however, to omit to notice a circumstance which it would be injustice to M. Vicat not to refer to. This is, that although the processes he has laid down for the manufacture of artificial hydraulic compounds are of a comprehensive nature, capable of accommodating their results to the exact wants of the architect in every situation, thus including all the various kinds of Roman Cements, &c.; yet, it will be observed, that his own practice seems to have been chiefly confined to the adoption of the hydraulic *limes*, in lieu of the more energetic cements more generally used in this Country. This preference may expose him to the opposition of many firmly-established usages and opinions, where the latter practice has so long and successfully prevailed, with respect to the justice of which it would not become me to hazard an opinion. M. Vicat has, however, relieved me from that necessity, by expressing his own very decidedly, in his declaration (in Chapter XV., Art. 263), that the superior adhesion of the hydraulic limes over our (so called) Roman cements, must inevitably, in time, give them the preference, whenever the comparative merits of the two are fairly known and appreciated. Now, without entering upon the discussion of this question, I may remark, that it appears to be one in which a contrariety of opinion may be occasioned by a difference of situation and circumstances. Thus it may perhaps be important, in considering the merits of the two systems, to recollect, that in one the means of minute mechanical division are an essential element, in the other, that it is unnecessary; and that this element which in one situation may be obtained at a cheap rate, may in another be expensive or unattainable. The hydraulic limes, therefore, which do not require to be *ground* previous to use, are at all events, whatever may be their other merits, more especially suitable to

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Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TRANSLATOR'S PREFACE.

xi

those situations where the facilities of mechanical agency cannot be resorted to. This circumstance would in itself be sufficient to justify M. Vicat's opinion; but I have now referred to it principally to point out, that the use of *ground cements*, valuable as they are in our constructions, are better adapted to the vicinity of a large capital, where it is of little importance that the builder becomes dependent upon others for his supply, than for a remote situation or a new country, in which the *unground* limes cannot fail to be preferred, from the facility with which they may be prepared by the mason himself. The difference, in fact, consists in this, that the *ground cements*, of whatever kind, will ever be furnished by *manufacturers*, whereas the hydraulic limes may at all times be prepared by the common workman, without machinery, and at a cost not much exceeding that of common lime (vide note to App. XVIII). And it will be in reference to this advantage, in addition to those pointed out by M. Vicat, and in opposition to the inconveniences which may be occasioned by the defect peculiar to them, their comparatively tardy solidification, that the engineer will be guided in making the selection best suited to his situation and exigencies.

Moreover, it is not merely in the accuracy of the details of his valuable invention, that M. Vicat has done the most service to the profession by the publication of his work; we must not forget the variety of other processes which he has illustrated and verified by numerous and exact experiments, and by which he has increased the resources of the practical engineer in every situation. And it is by the broad light thrown upon the relations of the numerous but ill-known ingredients, that he has placed within his reach a clew for the formation of compounds, hitherto guided by empirical rules, seldom derived from and therefore not adapted to the circumstances under which they are to be applied.

It now only remains for me to express my acknowledgments for the assistance of which I have availed myself, in the execution of my small part of this volume. Of the pub-

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978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

xii

TRANSLATOR'S PREFACE.

lished works to which I have had occasion to refer, I have made a point of duly stating the authority to whom I have been indebted; and to the distinguished authors to whom these obligations are due, I have merely to add the names of my friend Dr. Malcolmson, whose valuable services will be recognised in various parts of the Work, and of Colonel Sim, of the Madras Engineers, whose kindness in the ready communication of the results of his extensive experience in the processes for the manufacture of the celebrated mortars and stuccoes of Madras, has added another favour to the many debts of gratitude long due to him.

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978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TABLE OF CONTENTS.

SECTION I.

VARIOUS LIMES, OR AGENTS OF ADHESION IN CALCAREOUS
MORTARS AND CEMENTS.

CHAPTER I.

	Pages.
Of limestones, and the various limes they furnish.—Distinction of the known limes into rich, poor, and hydraulic limes. Characteristics of the different limes.—Method of distinguishing and classifying them.—Relation between the qualities of limes and the chemical composition of the stones whence they are derived	1

CHAPTER II.

Calcination of limestone on the large scale.—Conditions necessary to render the calcination as easy as possible.—Case of the rich limes.—Case of the hydraulic limes.—Different kilns made use of.—Average quantity of combustibles required for the calcination of a cubic metre of lime.—Irregular action of the coal kiln by slow heat	13
--	----

CHAPTER III.

Of artificial hydraulic limes.—Two modes of preparing them. Comparison between the hydraulic limes and the water-cements used in England.—Description of the processes followed by M. Saint Leger at Paris.—Average price of the artificial hydraulic limes	20
b	

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

ii

TABLE OF CONTENTS.

CHAPTER IV.

	Pages.
Of the slaking of lime.—Ordinary process.—How abused. Expansion of the different kinds of lime.—Effect of cold water upon rich lime in effervescence.—What renders lime sluggish in slaking.—Second process of extinction.—How it ought to be practised in order to reduce rich lime well. Water absorbed.—Expansion of the various limes, in powder not compressed.—Third process.—Water absorbed.—Expan- sion.—Order of the three processes in reference to the degree of division communicated to the lime.—Action of the carbonic acid of the atmosphere upon limes differently slaked.—Method of preserving the different limes before and after extinction	26

CHAPTER V.

Of the hydrates of lime, or solids resulting from the simple combination of water and lime.—Influence of the degree of consistency given to the hydrate in the first instance.—Ac- tion of the air.—Mode of exhibiting this action.—Action of the water.—Use that may be made of the hydrates in the arts.	34
--	----

SECTION II.

VARIOUS INGREDIENTS WHICH UNITE WITH LIME IN THE
PREPARATION OF CALCAREOUS MORTARS AND CEMENTS.

CHAPTER VI.

Of sands.—Of arenas.—Of psammites.—Of clays.—Of volcanic or pseudo-volcanic pouzzolanas.—Of the artificial products analogous to pouzzolanas.—History of these substances ...	43
---	----

CHAPTER VII.

Qualities of the ingredients mentioned in the preceding chapter.—Definitions—inert substances—slightly energetic	
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Cambridge University Press
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 Louis-Joseph Vicat Edited and translated by John Thomas Smith
 Frontmatter
[More information](#)

TABLE OF CONTENTS.

	iii Pages.
substances—very energetic ditto.—Insufficiency of their physical characters to denote the qualities specified under the above denominations.—Approximate chemical methods of recognising them; by means of acids, by lime-water ...	52

CHAPTER VIII.

Manufacture of artificial pouzzolanas.—What are the substances most proper for such fabrication.—Conditions to be fulfilled to attain the object.—Influence of a slight calcination and the contact of the air.—Nature and quantity of the ingredients in a good pouzzolana which are acted upon by muriatic acid	58
--	----

CHAPTER IX.

Mutual suitableness of the ingredients, with the various limes, in relation to the destination of the mortars or cements for the preparation of which we use them.—Case of constant immersion.—Case of alternations of dryness and moisture. Case of exposure to the weather	64
---	----

SECTION III.

COMBINATION OF THE ELEMENTS OF CALCAREOUS MORTARS AND CEMENTS.

CHAPTER X.

Mortars or cements intended for immersion.—Choice of proportions.—They are variable.—Limits established for certain cases.—The proportions exert a more important influence the less energetic the mixed substances are.—They must be modified according to the use for which the mixtures are intended.—Choice of the process of slaking.—Order of pre-	b 2
--	-----

Cambridge University Press
 978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
 Artificial and Natural
 Louis-Joseph Vicat Edited and translated by John Thomas Smith
 Frontmatter
[More information](#)

iv

TABLE OF CONTENTS.

Pages.

eminence of the three known processes, in reference to the nature of the lime made use of.—Manipulation or manufacture.—How it ought to be conducted under various circumstances.—Application to use, or immersion.—Difficulties to be overcome, how to manage them.—Old method defective. Action of the water upon the parts of immersed mortars or cements with which it is in immediate contact.—Influence of time 67

CHAPTER XI.

Mortars or cements constantly exposed to the weather.—Mode of correcting the bad qualities of rich limes.—Use of sand in different mortars.—Opinion of the ancients upon the quality of sands.—Influence of their size—it varies with different limes.—Method of mixing them.—Choice of proportions,—with rich limes,—with hydraulic limes.—Choice of the process of slaking;—it is the same as in the case of immersion.—Fabrication.—Conditions of a good manipulation.—Use—difficulties to be overcome.—How to attain the object.—Precautions in respect to drying to be taken after application.—Very remarkable influence of time upon mortars of rich lime, after many centuries 84

CHAPTER XII.

Mortars or cements subjected to the constant influence of a damp soil.—Influence of the coarseness of the sand.—Of the process of slaking.—Proportions.—Application to use.—Of concrete 98

CHAPTER XIII.

Of the vicissitudes to which cements and mortars may be exposed.—Influence of these vicissitudes.—Case of frosts.—Effects of the proportions and the size of well-mixed sands 102

Cambridge University Press
 978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
 Artificial and Natural
 Louis-Joseph Vicat Edited and translated by John Thomas Smith
 Frontmatter
[More information](#)

TABLE OF CONTENTS.

v

CHAPTER XIV.

Pages.

Influence of beating upon the resistance of mortars.—Cases in which it is more injurious than useful.—Difficulties which mortar when used as a plastic substance opposes to moulding.—Case in which these difficulties disappear 106

CHAPTER XV.

Natural cements.—Composition of the calcareous minerals which produce them.—Their advantages, their inconveniences.—All argillaceous limestones when imperfectly burnt afford natural cements 111

CHAPTER XVI.

Of ancient mortars compared with mortars of the middle ages. Description of the cement used in the Egyptian Pyramids. State of the art in Egypt;—amongst the Greeks;—amongst the Romans.—False opinion of the moderns as to the cause of the hardness of ancient mortars.—Known limits of absolute resistance of mortars 114

CHAPTER XVII.

Theories of calcareous mortars and cements; their insufficiency. M. John's experiments.—Macquer's hypothesis. Lorient and Lafaye's opinions.—Definitions.—Four cases presented by aggregates.—Probable consequences of the first case; ditto of second case;—ditto of third case;—ditto of fourth case.—Theory of the solidification of hydraulic limes.—M. Petot's experiments.—Remarkable influence of sand on the absorption of carbonic acid in old mortars. M. Berthier's opinion.—Its insufficiency.—Concluding remarks 124

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

vi

TABLE OF CONTENTS.

APPENDIX.

NOTES ON CHAPTER I.

No.	Pages.
1. History of lime and calcareous minerals	141
2. Chemical methods of appreciating the qualities of lime- stones.—Fruitless attempts of the ancients in this respect...	143
3. Of the way in which we have been enabled to add to the facts made known in 1818.—Authenticity of the new results	145
4. On the colour of limes	ib.
5. Method of analyzing a magnesian limestone by hydration	146
6. Account of the Madras magnesia	147
7. History of artificial hydraulic limes	150

NOTES ON CHAPTER II.

8. Effects of calcination on compound limestones.—Mutual re-action of the constituents	152
9. Influence of aqueous vapour upon the calcination of lime- stones.—Experiment by M. Gay-Lussac	ib.
10. Fact relative to calcination in a close vessel	153
11. Consequence of the imperfect burning of limestones. Contradictory experiments on this subject	154
12. Experiments upon the different quantities of combustibles used in the burning of lime	157
13. Sensible improvement which takes place in the burning of lime with coal, by very slight modifications in the manage- ment of the fire, and in the selection of the combustible ...	158
14. Irregular action of the coal kilns by slow heat (<i>feu continu</i>).—Use of turf	159
15. Kilns with alternative fires for the burning of argillaceous limestone—manner of using them	ib.

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TABLE OF CONTENTS.

vii

NOTES ON CHAPTER III.

No.	Pages.
16. Remarkable instances of the use of artificial hydraulic limes	161
17. Opinion of certain chemists on the efficacy of oxide of manganese in lime and mortars—Striking instance in opposition to that opinion	163
18. Details of the manufacture of artificial hydraulic lime on the first calcination under the most unfavourable circumstances	164

NOTES ON CHAPTER IV.

19. Examination of the vapour and gas disengaged during the slaking of lime	166
20. Opinions of the masons regarding lime which slakes to dryness	167
21. History of the various processes of slaking.—Examination of Fleuret's process	ib.
22. Numerical comparison of the bulks, with the quantities of water absorbed	168
23. Observations on the quantity of lime contained in equal bulks of the same consistency, of the different hydrates...	169
24. Remarkable fact of the indefinite preservation of rich lime in paste, in damp trenches	ib.
25. Notes regarding the preservation of limes slaked by immersion	170
26. Repugnance of the workmen to the use of hydraulic lime. Reasons of this repugnance	ib.
27. Methods made use of at Doué (Maine and Loire) to slake hydraulic lime, on the large scale and by immersion, and to convey it by the Loire	ib.
28. Experiment on a large scale on the preservation of quick-lime	171

NOTES ON CHAPTER V.

29. Definition of the hydrate of lime by chemists.—How to obtain it	171
30. Experiments on the absorption of carbonic acid by mortars	172

Cambridge University Press
 978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
 Artificial and Natural
 Louis-Joseph Vicat Edited and translated by John Thomas Smith
 Frontmatter
[More information](#)

viii		TABLE OF CONTENTS.	
No.			Pages.
31.	Progress of carbonic acid in the various hydrates of lime.		
	Analyses and remarks		173
32.	Use of unmixed lime in buildings.—Composition of the		
	Madras chunam		175

NOTES ON CHAPTER VII.

33.	Account of the use of arenas as pouzzolanas	177
34.	Of the use of certain psammities as pouzzolanas	ib.
35.	Use of pouzzolana by the Romans.—Dutch tarras	178
36.	Observations of Count Chaptal on the action of sulphuric acid on some pouzzolanas	179
37.	Experiment regarding the chemical inaction of lime towards quartz.—Ditto upon the inaction of hydraulic lime in the same circumstances	180

NOTES ON CHAPTER VIII.

38.	Account of some artificial pouzzolanas	182
39.	Opinion of certain builders regarding the efficacy of the oxide of iron—invalidated by facts	183
40.	Opinion of Colonel Raucourt, Engineer, upon the influence of the contact of the air in the calcination of artificial pouzzolanas.—The absorption of oxygen is not sufficiently established.—Investigation of the constituent principles of pouzzolanas separately mixed with rich lime.—Case in which it is impossible to overlook a chemical com- bination	ib.
41.	Reverberatory furnace proposed for the calcination of pouzzolanas—its inconveniences—other forms	186
42.	Experiments of M. Bruyère, Inspector-General of Roads, upon artificial pouzzolanas.—Repeated on a large scale by M. De Saint Leger	187
43.	Experiment tending to prove that clays calcined in contact with the air do not absorb any gas.—The clays which are calcined in a close vessel are not acted upon by acids to the same degree as those calcined in the air	ib.

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

TABLE OF CONTENTS.

ix

No.	Pages.
44. Research into the influence of the admixture of pure potash or soda with the clays previous to their calcination, in reference to the energy of the artificial pouzzolanas produced	189
45. Notice of Mr. Martin's new Patent cement	191

NOTES ON CHAPTER IX.

46. Explanation of the contradictions exhibited by various writings regarding mortars and pouzzolanas	191
47. Table of the composition of the various mortars and cements used by Mr. Smeaton	193

NOTES ON CHAPTER X.

48. Exceptions offered by the poor limes in relation to proportions	194
49. Explanation of the influence of the various methods of slaking	ib.
50. The exception of the hydraulic limes explained	196
51. Different ways of viewing cements and mortars	ib.
52. With reference to their texture and preparation	197
53. A mode of slaking approved by trial on a large scale	ib.
54. The methods of fabrication and immersion approved, by adoption on a large scale in the foundations of the bridge of Charles X. at Lyons	ib.
55. Fatal instance of the use of lime imperfectly slaked	198
56. Explanation of the deterioration of some water-cements and mortars.—M. Petot's experiments	199
57. Cases of exception applicable to what has been said regarding the influence of time	201

NOTES ON CHAPTER XI.

58. Experiment upon the influence of calcareous sand in comparison with granitic	201
59. Ancient examples, accidental or designed, in favour of the principles laid down regarding the influence of the coarseness of the grain in sands	202

Cambridge University Press

978-1-108-07151-2 - A Practical and Scientific Treatise on Calcareous Mortars and Cements,
Artificial and Natural

Louis-Joseph Vicat Edited and translated by John Thomas Smith

Frontmatter

[More information](#)

No.	Pages.
60. Ancient examples tending to prove the fatal influence of clay in mortars exposed to the weather	203
61. Explanation of the varied effects of the different methods of slaking	ib.
62. Unanimous opinion respecting mortars and cements mixed thin.—Means tried to effect kneading them very stiff ...	204
63. Method employed at the canal from Nantes to Brest, to guard the hands of the masons from the action of the lime.—Precautions to be taken relative to the soaking the materials used in masonry	206
64. The influence of slow drying upon the goodness of mor- tars known in Italy, and made use of in the fabrication of artificial stones	207
65. Remarkable instance of the time which mortar of rich lime requires to harden.—Chemical comparison of various old and ancient mortars of excellent quality.—Mode of reducing the results of chemical analyses into technical language	209

NOTES ON CHAPTER XIII.

66. Observations upon certain cases of deterioration of cements removed from a damp situation to a dry one	212
67. Compositions for the protection of stuccoes from the weather	ib.
68. Effects of frost upon mortars and cements.—Difficulty of explaining them.—Usual mode of experiment.—Remarks on the decay of mortars in the mild climate of India ...	213
69. Method proposed by M. Brard to distinguish substances liable to be affected by frost.—Application of that method to various mortars.—Brard's process does not answer with mixtures of this kind;—in respect to bricks and stones it may be of great service	216

NOTES ON CHAPTER XIV.

70. Poor success of Lorient's process applied to mortar consi- dered as a plastic substance.—Smeaton's remarks on ditto	219
--	-----