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WHY IS TYPE S HYDRATED LIME SPECIAL?

Margaret L. Thomson[1]

Abstract

Type S hydrated lime is defined by high early plasticity, high water-retention values, limited oxide content, and minimal coarse fraction. These qualities are highly valued for plaster and mortar. At the turn of the 19th Century in the United States, lime calcined from dolomitic limestone in Ohio was recognized as the best lime for interior plaster use. Starting about 1910, The American National Bureau of Standards, in collaboration with The National Lime Association and other masonry material producers, started what was to become a 30-year effort to characterize the nature of hydrated lime for building construction. They developed most of the methods of testing and definitions of key properties used in today's specifications. Commercial awareness of the value of producing a hydrated lime that would achieve all these properties in a reproducible manner led to two patented technologies that are used today. No other lime industry or standards development organization in the world has looked at hydrated lime in the same manner. The original characterization effort plays a continued important role in both the plaster and mortar industries of today.

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[1] Ph.D., Technical Manager, National Building Construction, Chemical Lime Company, margaret.thomson@chemicallime.com .

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WEAKER CAN BE BETTER: LEARNING FROM THE PAST CONTRIBUTES TO SUSTAINABLE CONSTRUCTION TECHNOLOGY WITH LIME

K. Van Balen[1], R. Hayen[2], and D. Van Gemert[3]

Abstract

Since the end of the 18th Century, building practices in Europe have reduced wall thicknesses and have generally used increasingly stronger binders. The paradigm of modern science has led to the search for strong and stiff mortars to make masonry. Faster setting has been advocated in order to shorten construction time. All of these factors encouraged the development of hydraulic binders and, eventually, portland cement. There is evidence, however, that the use of stiffer, stronger mortars has reduced masonry durability. In the field of heritage preservation, problems created by such mortars are most striking and obvious. To understand durability problems, the premises of the research that led to the development of modern materials must be questioned. The triaxial behaviour of lime mortar shows that lime mortar's low compressive strength does not jeopardize masonry strength and may increase masonry's long-term durability.

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[1] K. Van Balen, Associate Professor, K.U.Leuven, Civil Engineering department and R. Lemaire International Centre for Conservation, Belgium, koenraad.vanbalen@bwk.kuleuven.ac.be .
[2] R. Hayen, technical advisor, Arte Constructo, Belgium, technical@arteconstructo.be .
[3] D. Van Gemert, Professor, K.U.Leuven, Civil Engineering department, Belgium, dionys.vangemert@bwk.kuleuven.ac.be

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BUILDING LIME: SETTING THE STANDARD (ASTM & OTHER STANDARDS COMPARISONS)

Michael J. Tate[1]

Abstract

Carefully developed standards assist in the success of building products by assuring that they balance the needs of contractors, architects, owners and manufacturers. This paper provides an overview of standards related to building lime developed by organizations in the United States, Europe, Australia and Japan. The reasons for the requirements in these standards are discussed along the appropriate methods to measure the required properties. Differences and similarities between standards are explored. Based on this review, areas of current ASTM building lime standards that may be improved are discussed and suggestions are provided for future revisions.

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[1] Mike Tate, Technical Manager – Research and Development, Graymont Inc., United States, mtate@graymont.com

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GROUTING MASONRY USING PORTLAND CEMENT-LIME MORTARS

David T. Biggs[1]

Abstract

For commercial construction, masonry standards require that grout be used in reinforced masonry construction. Grout is made from a mixture of portland cement and aggregates with a maximum lime content of one-tenth the volume of the cement. For residential work, some standards allow reinforcing bars to be embedded in Type S or M mortar if modified by adding sufficient water to make the mixture “pourable”.

This research indicates that portland cement-lime based mortar has the potential to be an acceptable alternative for grout in reinforced masonry in modified, low-lift applications. In addition, grout proportioned with a higher percentage of lime, similar to mortar, could be acceptable as well. Further resea0ch is required to determine specific properties and define construction practices for each material.

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[1] P.E., Principal, Ryan-Biggs Associates, P.C., dbiggs@ryanbiggs.com

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THE EFFECTS OF AIR-ENTRAINED LIME ON CEMENT-LIME MORTARS

W. Mark McGinley[1]

Abstract

This research evaluates the effect of air entrained lime (Type SA) on the properties of cement-lime mortars. Tests comparing cement-lime and cement-air entrained lime mortars showed no significant differences in mortar water retention or flexural bond strength when combined with the standard concrete masonry units. Although higher air contents appeared to have some effect on the compressive strength of the mortars, the cement-air entrained lime mortars met the property specifications of ASTM C 270.

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[1] Professor, Civil, Architectural, Agricultural and Environmental Engineering, North Carolina A & T State University, Greensboro, NC, 27411, mcginley@ncat.edu

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LIME AND ITS PLACE IN THE 21ST CENTURY: COMBINING TRADITION, INNOVATION, AND SCIENCE IN BUILDING PRESERVATION

Lauren B. Sickels-Taves, Ph.D.[1]
Philip D. Allsopp, D.Arch, RIBA[2]

Abstract

Lime is a long-established material in mortars and renders, with its use dating back centuries. Its properties are time-tested, both in-situ and in laboratories. However, lime's marketability and the increased need for faster building in the 19th and 20th centuries decreased its widespread use. During this period, masonry integrity problems, and, later, sustainability concerns and increased mold risk were introduced into the built environment resulting from the widespread use of impervious materials including Portland cement for mortars and external renders. Evidence shows that lime has always been and remains a practical, sustainable, and healthy alternative to cement worthy of far more widespread deployment across the building industry.

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[1] Lauren B. Sickels-Taves, Assistant Professor of Historic Preservation, Department of Geography & Geology, Eastern Michigan University, lsickels@emich.edu .
[2.] Philip D. Allsopp, CEO, Apogee Informatics Corp., Philip_allsopp@apogeeinformatics.com .

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"PAST AND PRESENT USE OF LIME AS A BINDER IN MASONRY AND POINTING MORTAR" A PUBLICATION BY THE DUTCH MONUMENT SERVICE WITHIN A DUTCH-FLEMISH COLLABORATION

Koen Van Balen[1]

Abstract

In the fall of 2003, the Dutch Monument service (Rijksdienst voor de Monumentenzorg) published a book entitled "Past and Present Use of Lime as a Binder in Masonry and Pointing Mortar" (Van Balen et al. 2003b). The book resulted from a Dutch-Flemish collaboration. Its purpose was to disseminate knowledge on lime mortar to professionals in the field of architectural preservation. This paper presents an overview of the content of the publication, focussing on preservation issues.

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[1] K. Van Balen, engineer-architect, PhD in engineering, Associate Professor, K.U. Leuven, Civil Engineering department and R. Lemaire International Centre for Conservation, Belgium, koenraad.vanbalen@bwk.kuleuven.ac.be . President of the publication's editing group.

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LIME MORTARS: TWO RECENT CASE STUDIES

Joshua D. Freedland[1] & Edward A. Gerns[2]

Abstract

Over the last century, the increased use of portland cement-lime-sand mortars has led to a loss of empirical knowledge about workability, durability, and constructability issues related to lime-sand mortars by architects, conservators, scientists, and masons, especially in the United States. Recent published research has improved the knowledge base on the workability and durability of lime-sand mortars, but the requirements and limitations of lime-sand mortars related to constructability need to be relearned. This paper focuses largely on two recent case studies that included limited laboratory and field testing of lime putties for use in northern climates. Issues addressed include laboratory mortar compositional testing, mortar selection, carbonation rate, and the role of interfacing between materials suppliers, design professionals, contractors, and the individual masons on any particular project. The case studies provide two different approaches to the decision to use lime-sand mortars.

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[1] Joshua Freedland, Associate III, Wiss, Janney, Elstner Associates, Inc. Chicago, Illinois, USA, jfreedland@wje.com .
[1] Edward A. Gerns, Consultant, Wiss, Janney, Elstner Associates, Inc. Chicago, Illinois, USA, egerns@wje.com .

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HYDRATED LIME AS AN INGREDIENT IN HISTORIC RESTORATION REPAIR MATERIALS

M. P. Edison[1]

Abstract

The use of Type S hydrated dolomitic lime in the formulation of repair materials for historic structures has a long and successful performance history. This is true both for lime used as the sole binder and when used in combination with portland cement, alternative pozzolans, and/or synthetic binders. This paper reviews more than 20 years of performance history of repairs to historic buildings and monuments using specialty materials that incorporate Type S hydrated dolomitic lime. Applications discussed and illustrated include:

- Custom composite repair mortars for stone, masonry, and historic concrete
- Micro-injection grouts for masonry crack repair
- Void-filling grouts for seismic repairs and masonry stabilization
- Cement/lime stucco and stucco repair mortars
- Historic repointing mortars

Case studies are used to illustrate applications. Discussions of common errors in laboratory testing of lime mortars are also included.

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[1] President, Edison Coatings, Inc., Edison@edisoncoatings.com

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SMALL-SCALE TRADITIONAL LIME BINDER AND TRADITIONAL MORTAR PRODUCTION FOR CONSERVATION OF HISTORIC MASONRY BUILDINGS

John J. Hughes[1], Phillip F.G. Banfill[2], Alan Forster[3], Paul Livesey[4], Stuart Nisbet[5], Jane Sagar[5], David S. Swift[2], & Adrian Taylor[6]

Abstract

Two contrasting limestones were calcined for lime-binder production using a small vertical batch lime kiln. The conditions of firing were recorded and the quality of the product was evaluated using simple on-site methods and by manufacture and testing of mortars and masonry panels. Dry-slaking, or hot-lime mortar mixing methods were used for mortar manufacture. Problems were encountered with mortar hydration. However, the program revives interest in the practice of hot-mixed traditional lime mortars.

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[1] Historic Masonry Group, University of Paisley, Paisley, Scotland, john.hughes@paisley.ac.uk
[2] Heriot- Watt University, Edinburgh, Scotland.
[3] Scottish Lime Centre Trust, Charlestown, Scotland. Current address Laing Traditional Masonry, Aberdeenshire, Scotland
[4] Castle Cement, Clitheroe, Lancashire, England,
[5] Jacobs Babtie, Glasgow, Scotland 6 Buro Happold, Glasgow, Scotland

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VARIATIONS IN HIGH-CALCIUM LIME PUTTY AND MORTAR PROPERTIES RESULTING FROM THE USE OF FRESHLY-SLAKED QUICKLIME AND COMMERCIAL DRY HYDRATED LIME

Eric F. Hansen[1], Koenraad van Balen[2], & Carlos Rodriquez-Navarro[3]

Abstract

Many architects and architectural conservators specify the use of slaked lime putties, as opposed to commercial dry hydrates, with little technical knowledge of the differences in working properties of the putties or curing behavior and properties of the carbonated mortars. Mortars prepared from two lime types (both high-calcium) were characterized by 1) identifying differences in the textural quality of the particles and rheological behavior of the putties; and 2) testing the rate of carbonation and development of mortar strength over time. These test results are compared to previous work on aged lime putty in order to add to the general explanation for slaked lime behavior versus that of the hydrate. The lower plasticity, similar water retention and slower rate of carbonation of the commercial hydrate can be correlated with the particle size distribution, surface area, and mass of lime present in the mortars (respectively). As slaked lime putty ages, the mass of lime per unit area in the putty increases along with changes in crystal form (from prisms towards plates) and size (particle size decreases), affecting the working properties and development of physical properties.

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[1] E. F. Hansen, Scientist, The Getty Conservation Institute, U. S. A., ehansen@getty.edu
[2] K. van Balen, Professor, Katholieke Universiteit, Leuven, Belgium, koenraad.vanbalen@bwk.kuleuven.ac.be
[3] C. Rodriguez-Navarro, Associate Professor, University of Granada, Spain, carlosrn@ugr.es

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A CRITICAL REVIEW OF TECHNIQUES USED TO ACCESS CARBONATION IN LIME MORTARS

R.M.H. Lawrence[1]

Abstract

The carbonation process in high-calcium lime mortars, as well as the chemical, physical and environmental issues involved, are outlined. Literature on carbonation measurement is reviewed and the following techniques are examined: Scanning Electron Microscopy (SEM), Optical Microscopy (OM), Powder X-Ray Diffraction (XRD), Raman Spectroscopy, Differential Thermogravimetric Analysis (DTA), Phenolphthalein staining, Gravimetry, Velocity of the Propagation of Ultrasound Pulses, Elemental Analysis, Drilling Resistance Measurement System (DRMS) and electronic pH measurement. An examination is made of the reasons for which information on carbonation is required, and appropriate techniques for assessing carbonation, based on each reason, are identified. The need for research into the relationship between the evolution of carbonation and the evolution of pore structure is discussed. Preliminary results from research in this area by the author are reported. Tentative proposals are made for an internationally-accepted Standard Protocol.

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[1] R.M.H. Lawrence, University of Bath, United Kingdom, abmrmhl@bath.ac.uk

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DEVELOPMENT OF A STANDARDIZED LABORATORY APPARATUS FOR MEASURING EMLEY BASEPLATE RATE OF ABSORPTION

R.J. Godbey[1] and M.L. Thomson[2]

Abstract

ASTM C 110-04, Standard Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone, mandates requirements for the rate of absorption of Emley Plasticimeter baseplates. However, beyond a short, non-mandatory note, the current test method does not provide guidance for constructing an apparatus to measure baseplate rate of absorption. This paper outlines the construction and use of such an apparatus.

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[1] Richard J. Godbey, Chemist, Chemical Lime Company, richard.godbey@chemicallime.com .
[2] Margaret L. Thomson, Ph.D., Technical Manager-Type S, Chemical Lime Company, margaret.thomson@chemicallime.com .

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AUTOCLAVED AERATED CONCRETE: A LIME-BASED TECHNOLOGY

Ronald E. Barnett, P.E.[1]

Abstract

Autoclaved Aerated Concrete (AAC) is a non-combustible, lime-based, cementitious building material that is expanding into new worldwide markets. As a single-component building material, AAC has achieved acceptance in new markets throughout the world. AAC provides a structural building system with inherent properties that include thermal insulation, acoustical insulation, and excellent fire protection ratings. This paper will describe the production, material properties, construction applications, and building code developments for AAC throughout the United States.

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[1] Ronald E. Barnett, P.E., Vice-President / General Manager, AERCON Florida, LLC, U.S.A., rbarnett@aerconfl.com .

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MECHANICAL PROPERTIES OF LIME-BASED MASONRY BLOCKS IN EUROPE

Gero A. Marzahn[1]

Abstract

This paper investigates mechanical properties, such as strength and deformation parameters, under short-term and long-term loading conditions on lime-based masonry blocks. Beyond basic properties, which are required by testing standards for masonry products, the paper's focus is on mechanical characteristics whose testing is not required by current standards. Deformation-controlled tests were used to observe stress-strain relationships of blocks in pre- and post-peak range as well as values of compressive and tensile axial strength. Deformation parameters, such as Young's modulus and Poisson's ratio, could also be inferred from the tests. Masonry block trials with long-lasting compression loads were used to determine sustainable strength, and to obtain insights into the creep and shrinkage behavior of the block materials.

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[1] Gero A. Marzahn, Dr.-Ing., University of Leipzig, Institute for Concrete Structures and Structural Materials, Leipzig, 04109, Germany and Northrhine-Westfalia Dept. of Transportation, 50679 Cologne, Germany, G.Marzahn@gmx.de

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LIME – A SUSTAINABLE "GREEN" BUILDING PRODUCT?

Wayne Kenefick[1] & Michael Tate[2]

Abstract

This paper suggests that lime is both a sustainable and "green" building product. Sustainability is assessed through examination of limestone as a natural resource, energy requirements for lime production, and the carbon balance. Limestone availability is reviewed in the context of consumption, the limestone geochemical cycle, and the natural formation of limestone. Energy-efficiency in lime production and the carbon cycle in the production and use of lime are discussed. The "green" attributes of lime as a building product are presented. These attributes are discussed in terms of how the use of lime may assist in "green" building certification under programs such as LEED™.

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[1] Wayne Kenefick, Director of Sustainable Development, Graymont Limited, Canada, wkenefick@graymont-ab.com
[2] Mike Tate, Building Lime Sales Manager, Graymont Dolime (OH) Inc., United States, mtate@graymont-oh.com

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MULTIPLE USES OF LIME IN MEXICAN PUBLIC HOUSING: MORTAR, BLOCK, PLASTER, PAINT AND SOILS

A. Vazquez[1], J. Marquez[2], and E. Macias[3]

Abstract

During the past few years, the Mexican government has increased the quantity of low interest loans available to low-income workers to purchase decent housing. In the construction of this type of dwelling, special efforts are made to maintain low material costs without affecting the quality of the dwelling. As construction costs continue to rise, companies are looking for more creative ways to use building materials in order to be profitable in this market. Lime plays an important role in this market. It can be used in the construction of these dwellings in soil stabilization, mortar for union bricks, production of block, renders, and lime paints.

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[1] A. Vazquez, Marketing Manager, Grupo Calidra, México, avazquez@calidra.com.mx
[1] J. Marquez, Comercial Director , Grupo Calidra, México, jmarquez@calidra.com.mx
[1] E. Macias, New Markets Research, Grupo Calidra, México, emacias@calidra.com.mx

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LIME APPLICATIONS IN SITE AND INFRASTRUCTURE CONSTRUCTION

Eric A. Berger[1]

Abstract

Lime soil stabilization plays an important role in transportation and industrial/commercial development. Fine grained clay soils that are generally regarded as unsuitable for structural use can be chemically transformed into strong, stable, non-expansive materials that make a structural contribution to infrastructure built on them. The chemical transformation is permanent and can result in significant cost savings over other engineering solutions. The paper examines the chemistry of the lime/soil reaction, proposes design and testing protocols, describes fundamental quality control procedures, and highlights cost benefits that may be achieved by choosing lime stabilization.

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[1] Eric A. Berger, Project Manager, R&D, Chemical Lime Company, USA, eric.berger@chemicallime.com

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THE USE AND EFFECTIVENESS OF DISPERSED HYDRATED LIME IN CONSERVATION OF MONUMENTS AND HISTORIC STRUCTURES

P. Miller[1], M. Rabinowitz[2], & J. Sembrat[3]

Abstract

The use of dispersed hydrated lime (DHL) injection grout for repair of historic and artistic exterior masonry is a relatively new technique in the field of conservation. As a repair material to stop the ingress of water, DHL is preferable to other fill materials because it is completely compatible with marble, limestone, and sandstone; stable in sunlight; reversible; easy to color-match; and adaptable to the thinnest and deepest of cracks without needing to enlarge them. These characteristics make it very attractive for the most aesthetically sensitive of projects requiring treatment of cracks and small fissures in statuary, monuments, and buildings. Case studies are presented that document methods and materials for DHL-based repairs, provide results of accelerated weather testing, and yield observations from several seasons of field monitoring. Findings from recent field modifications to treatments, based on the performance of DHL as a crack repair material, are discussed.

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[1] Conservator, Conservation Solutions Inc., Professional Associate of American Institute for Conservation of Historic and Artistic Works (AIC), pattymiller@conservationsolution.com
[2] Vice President, Conservation Solutions Inc., Fellow of AIC, markrabinowitz@conservationsolution.com
[3] President, Conservation Solutions Inc. Professional Associate of AIC, joesembrat@conservationsolution.com

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LISTEN TO THE MASON: PORTLAND CEMENT-LIME TYPE N MORTAR (1:1:6) PROVIDES THE NECESSARY WORKABILITY AND STRENGTH

Rick Gunn[1]

Abstract

In the Midwest United States, portland cement-lime mortars are the most commonly used for commercial masonry projects. Type S mortars, with one part cement, one-half part lime, and four-and-one-half parts sand (by volume), are the most commonly specified. There is a perception in the engineering community that higher compressive strength mortars are required to achieve better masonry. In listening to masons, I hear their cry "THIS MORTAR IS TOO STRONG." One rarely hears a mason say they prefer Type S mortar. Given the opportunity to choose, a mason would select a Type N mortar -- one part cement, one part lime, and 6 parts sand (by volume). They choose a Type N mortar because of the workability of the mortar, not to mention the board life, yield, cleaning, and production gained with a higher lime-content mortar.

With 14 years of experience in the masonry industry, starting as a laboratory field technician and now as a pre-blended bulk mortar designer and sales representative, I cannot help but become an advocate of the "masons on the wall." The mason's most important tool is mortar and the mason should have the best tools. The compressive strength of a portland cement-lime Type N mortar is usually adequate to produce masonry that meets or exceeds the code-required masonry assemblage compressive strength and provides better workability than Type S.

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[1] Bulk Mortar/ Construction Products Sales, QUIKRETE-Dallas, bengun@comcast.net

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THE MOST IMPORTANT PROPERTY OF CEMENT-LIME MORTAR IN MASONRY CONSRTRUCTION IS…

Michael J. Tate[1]

Abstract

Cement-lime (CL) mortar has a number of properties that are beneficial in masonry mortar applications. The most important property is dependent on the user and application. By varying the ratio of cement to lime, the characteristics of CL mortar can be adapted to the specific application. This paper discusses mortar properties architects and contractors consider important. For each of these properties, the influence of lime in mortar is explored. Properties detailed in the paper include bond strength, compressive strength, and workability. Research describing the impact of the use of lime on each property is discussed. The flexibility of lime-based mortars to meet a wide range of needs in both new construction and restoration masonry projects is demonstrated.

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[1] Graymont Dolime (OH) Inc., mtate@graymont-oh.com

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LIME POZZOLAN BINDERS: AN ALTERNATIVE TO OPC?

B. Middendorf[1], J.F. Martirena[2], M. Gehrke[3], and R. L. Day[4]

Abstract

This paper presents research focused on building materials using pozzolanic mixtures of ash from agricultural waste combined with lime or a very small amount of portland cement (OPC). High energy costs and CO_2 emissions associated with OPC production in the last few decades have prompted the use of cement-replacement materials. Pozzolanic binders prepared by burning agriculture waste combined with lime can be used as partial or complete substitutes for OPC. Agricultural wastes are widely available in huge amounts in many developing countries. The reactivity of these ashes depends on the chemical composition and on several factors involved in the burning process. A combination of lime and/or OPC and the above-mentioned reactive pozzolan can react as a "blended hydraulic lime" suitable for use as a mortar binder for masonry construction or as a "blended cement" for concrete production.

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[1] B. Middendorf, PhD, Senior Scientist, Dept. of Structural Materials, University Kassel, Kassel, Germany, midden@uni-kassel.de
[2] J. F. Martirena, Professor, Universidad Central de las Villas, Santa Clara, Cuba
[3] M. Gehrke, Chemical Engineer, Dept. of Structural Materials, University Kassel, Kassel, Germany
[4] R. L. Day, Professor, Dept. of Civil Engineering, University of Calgary, Calgary, Canada

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STUDY OF HYDRATION OF BINDING SYSTEMS IN LIME-BASED MORTARS FOR REPAIRING HISTORICAL STRUCTURES

I. Papayianni[1] & St. Konopissi[2]

Abstract

The scope of this experimental work was to observe the hydration process and to find criteria for selection of a suitable binding system for new repair mortars, relative to strength and durability. Binding systems based on hydrated lime (powder or putty) combined with other binders (pozzolan, brick dust, clay, white cement), as well as hydraulic hydrated lime, were studied by preparing pastes of a predetermined consistency. The following measurements were made at different ages: a) mechanical properties (compressive and flexural strength), b) porosity, c) carbonation products, d) mineralogical analysis and e) microstructure (crystal lattice, size and crystal contacts) observations. From the test results, a correlation was made between reactivity of the binders and strength development with time. Among 14 paste mixtures, the mixture with a proportion of lime:pozzolan of 1:1 was found to have higher mechanical properties, lower porosity values and a fine crystallized microstructure after a 90-day period.

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[1] Professor, Civil Engineering Department, Aristotle University of Thessaloniki, Greece, papayian@civil.auth.gr
[1] MSc Chemist, Civil Engineering Department, Aristotle University of Thessaloniki, Greece

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INFLUENCE OF THE FINES IN NATURAL SANDS AS POZZOLANIC COMPONENTS ON THE INTERPRETATION OF THE ACID-SOLUBLE SILICA CONTENT OF HISTORIC LIME MORTARS

B. Middendorf[1], K. Kraus[2], and Chr. Ott[3]

Abstract

Chemical analyses of historic lime mortars usually show a considerable amount of acid-soluble silica, which can be considered to be hydraulic components of the used lime. Investigations have shown that the heat released by the reaction of quicklime with natural sand is able to convert the fines (clay minerals) into pozzolanic components. Lime mortars of hydrated lime or quicklime, with untreated and washed sands, were prepared. The physical-mechanical properties of the mortars were determined after carbonation. Mortars prepared from untreated (unwashed) sands and hydrated lime or quicklime showed improved strength properties. The reaction products are susceptible to acid treatment and may be responsible for the enhanced acid-soluble silica content of historic lime mortars. Therefore, high acid-soluble silica content of a historic lime mortar may not provide clear evidence for the use of hydraulic lime as binder material.

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[1] B. Middendorf, PhD, Senior Scientist, Dept. of Structural Materials, University Kassel, Kassel, Germany, midden@uni-kassel.de
[2] K. Kraus, PhD, Head of the Institute of Stone Conservation, Mainz, Germany
[3] Chr. Ott, Research Assistant, Institute of Non-Metallic Materials, Clausthal University of Technology, Clausthal, Germany

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LIME-POZZOLAN MASONRY MORTAR

A.L. Moncada[1] & R.J. Godbey[2]

Abstract

For centuries, lime and sand have been used in masonry mortar throughout Mexico. However, some masons are changing to quick-setting, very high compressive strength portland cement-admixture mortars (*mortero*). These masons are changing because: a) mortero comes pre-bagged, needing only the addition of the correct amount of jobsite sand and water; and b), bagged mortars help to insure consistent quality mortar. The main problem with mortars that achieve excessive compressive strength is incompatibility with relatively soft masonry units. To honor Mexican masonry traditions and, at the same time, satisfy the workability requirements of masons, a ready-to-use hydraulic lime (lime-pozzolan) mortar has been developed. The lime-pozzolan mortar has superior working properties, good yield, and moderate compressive strength. This paper provides comparative test data for lime-pozzolan and mortero mortars including, but not limited to, compressive strength, sand carrying capacity, board life (setting time), and unit masonry yield.

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[1] A.L. Moncada, Marketing Manager, Grupo Calider, Mexico, lmoncada@grupocalider.com
[2] R.J. Godbey, Chemist, Chemical Lime Company, USA, richard.godbey@chemicallime.com

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POZZOLANIC MATERIALS – EVOLUTION OF MECHANICAL PROPERTIES

Ana Luísa Velosa[1] & Maria do Rosário Veiga[2]

Abstract

Natural pozzolans from different origins were characterised and used to make lime-pozzolan mortars. Mortars with these materials have been used since ancient times and the knowledge of their properties contributes toward understanding their performance as renders. A special emphasis was put on the evolution of their mechanical properties through a period of time up to 3 years, resulting in varied patterns depending on the proportion of materials and curing conditions. However, in a general sense, mechanical properties decreased with age, a finding that must be complemented by other analysis techniques, such as SEM, in order to evaluate the micro-structural changes in mortars that induce this phenomenon.

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[1] Universidade de Aveiro, Campus Universitário de Santiago, 3810 - 193 Aveiro, Portugal, avelosa@civil.ua.pt
[1] Laboratório Nacional de Engenharia Civil, Avenida do Brasil, 1011700-066 Lisboa, Portugal, rveiga@lnec.pt

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REVIVING NEW ORLEANS' OLDEST CEMETERY: PRESERVATION OF ST. LOUIS CEMETERY NO. 1 THROUGH THE RE-INTRODUCTION OF TRADITIONAL MATERIALS

Dorothy S. Krotzer[1]

Abstract

St. Louis Cemetery No. 1 is the oldest of New Orleans' early Creole cemeteries. However, years of abandonment and vandalism have taken their toll on the site, contributing to loss of physical integrity and historical character. To arrest the physical deterioration and initiate a program of sound preservation for the cemetery, the non-profit entity Save Our Cemeteries, Inc. obtained a grant from the federal Save America's Treasures (SAT) program in 2001. The funding went towards the development and implementation of a preservation program for some of the most threatened and significant tombs in the cemetery. The program included the restoration of an entire alley of tombs (or "tombscape") within the cemetery through the re-introduction of historically appropriate materials, such as lime washes and hydraulic lime-based stuccos. The goal was to provide an alternative approach for the repair of deteriorated tombs, other than the cast-in-place concrete construction in use at the time. The use of historically appropriate and compatible materials allows these structures to be repaired instead of replaced, thus encouraging their long-term preservation.

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[1] Conservator, Dorothy S. Krotzer Architectural Conservation, dkrotzer@mindspring.com .

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PHYSICAL AND CHEMICAL EVOLUTION OF LIME MORTARS FROM TOURNAI (BELGIUM)

G. Mertens[1], J. Elsen[1], A. Brutsaert[2], M. Deckers[2], and R. Brulet[2]

Abstract

The characterization of historical mortars, ranging in age from Roman to Romanesque, was performed by a combination of microscopic, wet chemical, XRD diffraction and DTG techniques. The samples were taken from remnants of different constructions that were exposed under the present-day floor-level of the Romanesque Cathedral 'Notre Dame' at Tournai.

Roman mortars were found to differ significantly from their older homologues by the use of a high proportion of lime and the addition of ceramic fragments of well-defined size. From a mineralogical-geochemical point of view, both the lime binder and the lime lumps have evolved since their original application, but these systems must have been subjected to quite different processes.

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[1] G. Mertens, Prof. Dr. J. Elsen, Afdeling Fysico-chemische Geologie, Katholieke Universiteit Leuven, Belgium, Gilles.Mertens@geo.kuleuven.ac.be .
[2] A. Brutsaert, M. Deckers, Prof. Dr. R. Brulet, Centre de Recherches d'Archéologie Nationale, Université Catholique de Louvain, Belgium, Brulet@arke.ucl.ac.be .

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A BRIEF HISTORY OF THE USE OF ROSENDALE CEMENT IN THE U.S. (1818-1900) WITH A PRELIMINARY CASE STUDY OF FORT JEFFERSON, FLORIDA

Mary Catherine Martin[1] and Ken Uracius[2]

Abstract

A significant masonry binder used in the United States from 1818 to 1900 was natural cement also known as Rosendale Cement. Hydraulic limestone, also known as cement rock, quarried primarily in the region of Rosendale, NY, is a stone of variable content. Depending from which strata of the formation the stone is extracted, the stone may be high in carbonates, or may have an elevated clay and silicate content. Through trial and error, the manufacturers of natural cement created a variety of products that involved the proportional mixing of stone from varying strata. The presenters will discuss the history and use of Rosendale natural cement, particularly its use in civilian and military construction in the United States.

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[1] Mary Catherine Martin, AIA, Preservation Architect, Lord, Aeck, & Sargent, Inc., Atlanta, GA, USA, mcmartin@lasarchitect.com.
[1] Ken Uracius, Mason, Stone and Lime Imports, Inc., Holden, MA, USA, kuracius@charter.net

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CONCRETE EVIDENCE: PRELIMINARY ASSESSMENT OF THE EFFECTS OF HERBICIDES ON LIME CONCRETE

R. M. Porter, Jr.[1]

Abstract

Although lime has been adopted as an ingredient of mortar in a variety of locales in the United States, it has found other roles. Among these latter adaptations was its appearance as an ingredient in lime concrete—the material adopted for the construction of the majority of the facilities at Fort Laramie, formerly a strategic garrison on the frontier and presently a National Historic Site. Among the challenges in its preservation is avoidance of damage to the historic fabric during the eradication of unwanted vegetation. Experimentation with applications of two herbicides to vegetation and samples of lime concrete during a single season revealed effective control of vegetation without visible effects on the composition or color of the material. Further experimentation will be conducted to determine the long-range effects of these applications.

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[1] Assistant Professor, Department of Civil and Architectural Engineering, College of Engineering, University of Wyoming, rmp@uwyo.edu

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THE STRANGE HISTORY OF THE ENGLISH LIME REVIVAL

Bruce Induni[1]

Abstract

This paper uses data from extensive personal communication and published sources to analyse the following issues:

- Why is current English lime use concentrating on hydraulic lime and rejecting other mortar options?
- Does historic custom and practise offer lessons for the future?

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[1] At the time of publishing, Lecturer, Bournemouth University, Dorset, England, BInduni@bournemouth.ac.uk

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3E WALL FOR ALL CLIMATES: PART 1. THE PROBLEM

Mark Bomberg[1], Marcin Pazera[2], and Paul Ellringer[3]

Abstract

Moisture-originated failures in stucco-clad walls have been reported in the coastal climate of the Canadian Province of British Columbia as well as in the cold climates of Alberta and Minnesota. Damages are often attributed to poor design and water penetration at windows, balconies and walkways. Yet, there is a misconception about moisture control of exterior stucco (rendering) systems. Despite the recent failures, the authors postulate that wood-framed walls with stucco cladding placed on an exterior insulation over oriented strand board (OSB) protected by waterresistive barrier (WRB), and with cellulose fiber insulation within the wall framing can be one of the most economical and ecologically-justified systems that will perform well in most climates. This 3E wall system is designed for energy efficiency, environmental control and ecological responsibility. However, the approach in which building envelopes (BE) are currently designed must be changed.

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[1] Syracuse University, Syracuse, NY, mbomberg@syr.edu
[2] Syracuse University, Syracuse, NY
[3] Air Tamarack, St. Paul, MN, paul@airtamarack.com

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3E WALL FOR ALL CLIMATES: PART 2: A PROPOSED SOLUTION

Mark Bomberg[1], Marcin Pazera[2], and Paul Ellringer[3]

Abstract

Recent failures of exterior stucco on walls were discussed in the first part of this paper. After assessing those problems, the authors postulate that providing stucco with a capillary breaking layer combined with exterior thermal insulation and improved ability of the wall to dry both outwards and inwards will restore the excellent track record for which exterior stucco walls were known forcenturies. This 3E wall system is designed for energy efficiency, environmental control, and ecological responsibility.

The authors highlight that exterior stucco should be applied on exterior insulation in both hot and cold climates. The system should incorporate water resistive barriers (WRB) and cellulose fiber insulation in the framing cavities. Such a wall can be one of the most economical and ecologically-justified systems that will perform well in most climates. However, such a wall should also be designed with a different paradigm for heat, air and moisture control of the building envelope (BE). A new paradigm should be based on moisture balance in relation to climatic and service conditions. In this context, modern lime-cement rendering placed on thermal insulation and provided with proper architectural detailing may successfully compete with all other cladding systems.

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[1] Syracuse University, Syracuse, NY, mbomberg@syr.edu
[2] Syracuse University, Syracuse, NY
[3] Air Tamarack, St. Paul, MN, paul@airtamarack.com

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ASPECTS OF SALT AND MOISTURE TRANSPORT IN RESTORATION RENDERS (PLASTERS)

Caspar Groot[1], Rob van Hees[2], Barbara Lubelli[3], Tomas Wijffels[1], Mario de Rooij[1], & Jelena Petkovic[4]

Abstract

There is a need for obtaining more knowledge about renders (plasters) used in restoration because of cases of damage observed in the field. The currently applied and available restoration renders do not always meet the requirements.

By analyzing damage cases it becomes clear that the performance of modern and traditional renders, under salt load is not fully understood. In order to gain a better understanding of salt migration through renders and to promote better practices regarding the application of restoration renders, the European research project COMPASS (compatibility of renders with salt-loaded substrates in historic buildings) was launched. In this paper, preliminary findings from project are presented.

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[1] TU Delft, NL
[2] TNO Delft, NL
[3] TUD, TNO Delft, NL
[4] TU Eindhoven, NL

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TECHNOLOGY USED IN THE PRODUCTION OF ANCIENT MAYA MORTARS AND PLASTER

E. F. Hansen[1]

Abstract

The general technology likely used by the ancient Maya to produce mortars and plasters can be suggested from available archaeological evidence, laboratory analysis of ancient materials, replication of technology experiments, and ethnoarchaeology. The technology likely involved lime burning on stacked-wood open fires (no enclosed kilns), air slaking of quicklime, limestone-derived aggregates, and a variety of organic additives. However, sufficient evidence regarding the manner of slaking the lime and the use of organic additives, even though past use is suggested by current practice in remote areas of the Maya region, is difficult to obtain.

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[1] E. F. Hansen, Ph. D., Scientist, The Getty Conservation Institute, U.S.A ehansen@getty.edu

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THEORETICAL CONSIDERATIONS ON CONSERVATION INTERVENTIONS

A. Elena Charola[1] and Fernando M.A. Henriques[2]

Abstract

The current concept of conservation emphasizes the importance of architectural heritage as both a work of art and a historic document. However, as illustrated in the examples discussed in the paper, this concept may lead to contradictory technical approaches during a conservation intervention. The reason can be found in the fact that conservation is a cultural activity rather than a merely technical one. To find the right approach to conservation, the values to be preserved must be determined a priori, requiring a careful balance between the various disciplines that make up the conservation field. In most cases, resorting to the traditional methods used in the original construction may be the best solution. However, several cultures contributed their technology and expertise to construction in America at different times. Trying to re-capture the traditional crafts that originated the structures that are to be conserved may be problematic in this situation.

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[1] Independent Scientific Consultant. Lecturer, Graduate Program in Historic Preservation, School of Design, University of Pennsylvania, USA aech@verizon.net
[2] Professor, Universidade Nova de Lisboa – DEC, Portugal fh@fct.unl.pt

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LIMEWASH: COMPATIBLE COVERINGS FOR MASONRY AND STUCCO

Peter Mold[1] & Richard Godbey[2]

Abstract

Limewash is a versatile, accommodating, and robust surface covering that is compatible with a variety of building surfaces. It is maintainable, beautiful, stable, and long lasting. It is an aesthetic statement to many cultures, from the white houses of Greece, to earth tones of the southwest United States. This paper takes an on-site look at the practical aspects of limewashing on a wide variety of substrates and in a wide range of climates, including:

- Types of compatible substrates;
- Preparation of the substrate for lime washing;
- Use of pigments and additives;
- Application techniques on different substrates;
- Application techniques in different climates; and
- Maintenance.

The authors combine their experiences from both the science of lime and the practical application of lime, stone, and earth construction in Europe, America, and Australia--from lime plastering the Globe Theatre in London, England to lime washing modern three-coat stucco in Las Vegas, Nevada.

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[1] P. Mold, Worker in Lime, Stone and Earth, UK & USA, peter_mold@yahoo.co.uk
[2] R. Godbey, Chemist, Chemical Lime Company, USA, richard.godbey@chemicallime.com

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FRESCO PAINTING: THE DICHOTOMY OF RIGOROUS CRAFT AND ARTISTIC EXPRESSION

Tessa Lindsey[1]

Abstract

In this paper, the term “fresco” is used to describe *buon fresco* technique: painting executed on fresh lime plaster while the plaster is still wet, so that the pigments, diluted in water only, are fixed by carbonation of the lime.

Fresco technique has been used in mural painting for millennia by diverse people and artistic traditions. It has left an enormous legacy due, in no small part, to its high degree of permanence. Although this legacy fuels passionate interest in historic frescoes and their conservation, the painting method itself—with its traditional craft origins—has fallen into obscurity.

This paper presents an overview of the fresco process and materials, which revolve around lime. To promote consideration of fresco as a contemporary medium, exact observations and comparisons of different lime products in a fresco application will be given, along with specific requirements for “good” fresco carbonation. Furthermore, a look at modern support panels will serve to extend the range of application beyond the traditional wall.

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[1] Tessa Lindsey, Fresco Painter, Colour & Surface, U.S.A., tessalindsey@yahoo.com .

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A CASE STUDY IN INTERVENTION ON ORIGINAL SURFACES

Maria Margalha[1]

Abstract

A new interest in preservation of mortars, plasters and decorative finishes on façades has emerged in certain European countries in the past thirty or forty years, with a view to understanding how they have evolved throughout history. In Portugal, this type of study is relatively new, but a growing interest in learning about the composition of original surfaces has been observed, and a number of Institutions have encouraged systematic application of conservation techniques in this area. This paper discusses some methodologies used to assess the condition of original surfaces and the structural repairs carried out at a church in a small village in southern Portugal. The church dates back to the beginning of the 16th century, but it underwent significant alterations in the 17th, 18th and 19th centuries.

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[1] Civil Engineering, City Hall of Beja, mgoreti@netvisao.pt

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