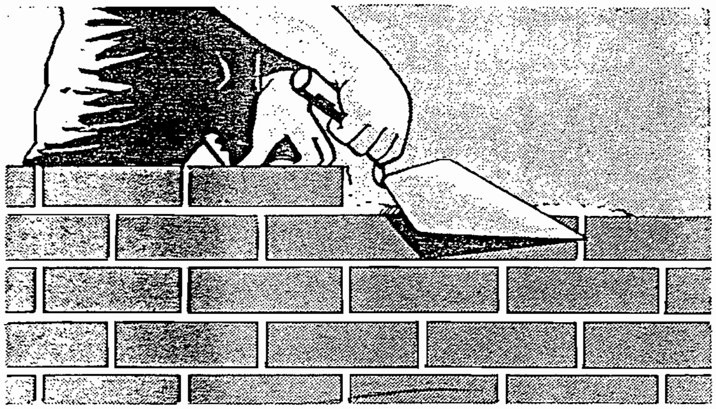
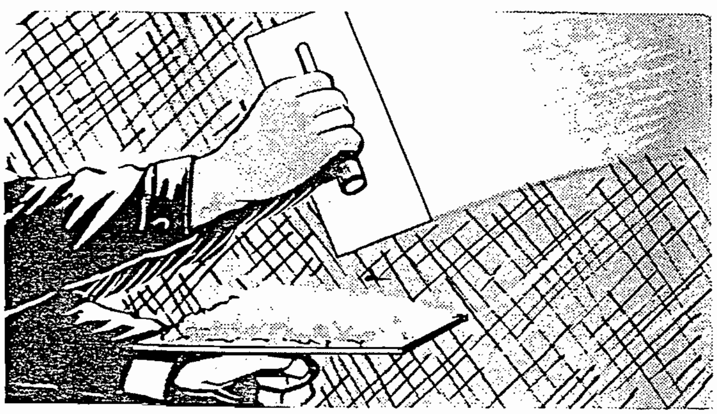
Lime



For Unit Masonry



For Plaster

Exterior and Interior

For Soil Stabilization

and Drying Up Building Sites

NATIONAL LIME ASSOCIATION

5010 WISCONSIN AVE., N.W., WASHINGTON, D.C. 20016

for superior masonry construction

specify lime mortar

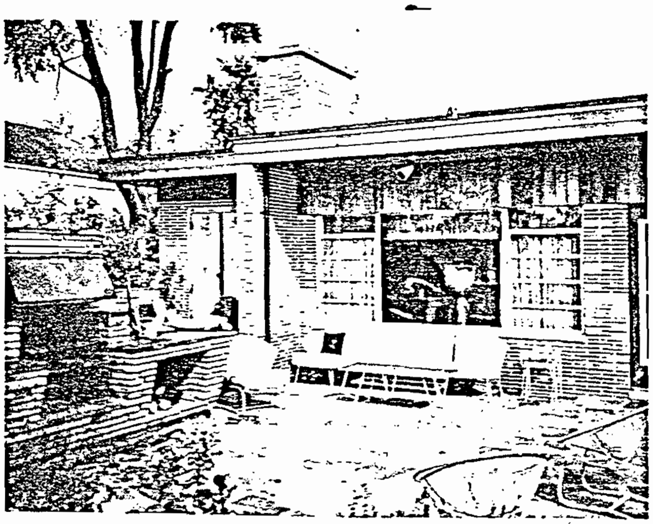
Construction of sound masonry walls that are durable, weather resistant and require low maintenance depend on the following factors:

1. Good architectural design, including relief joints where applicable.
2. Highest quality mortar which has good workability, high water retention, strong bond, proven durability and weather resistance.
3. Sound masonry units with low volume change and moderate rate of water absorption (suction).
4. Proper workmanship, including the complete filling and tooling of all joints.

lime is essential for high quality mortar

The essential ingredient for a good, all-purpose mortar is LIME . . . whether it is job-mixed with portland cement, prepared masonry cement or is central-mixed (ready mixed mortar).

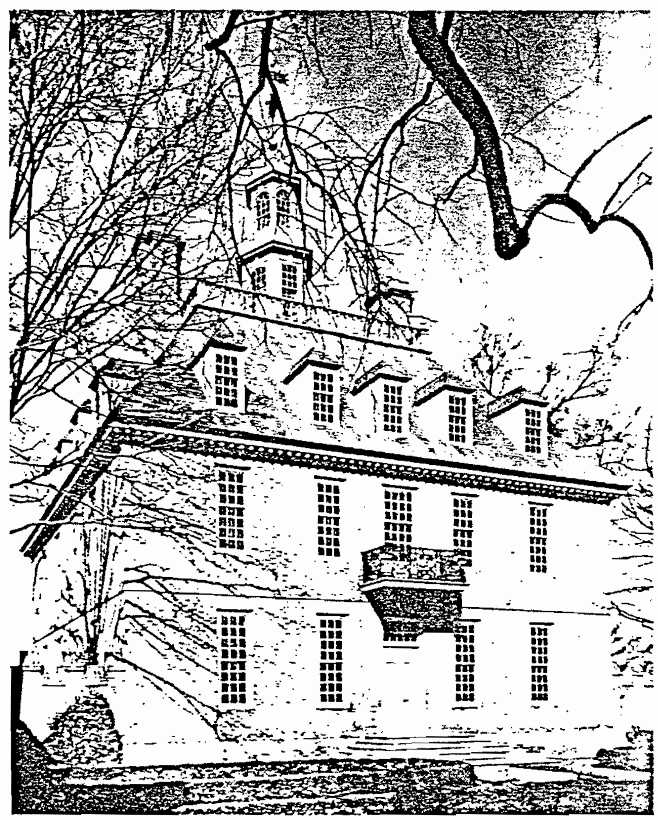
Be sure that the mortar contains LIME (calcium or calcium-magnesium hydroxide) and not inexpensive inert fillers like pulverized limestone (calcium carbonate). Also, be sure that it contains enough lime to provide a workable, durable mortar that will provide watertight, sound masonry—at low cost.



Modern suburban residence in Scarsdale, New York

A combination of brick, stone, and flagstone masonry. Mortar used throughout was one part portland cement, one and one-half parts lime putty and six parts sand by volume.

Architect: H. Herbert Lilian   Contractor: Morris Rosen & Sons



Governor's Mansion in restored Williamsburg, Va.

An example of beautiful brick masonry. All masonry laid with a mortar of one part cement, two parts hydrated lime, and six parts sand to which was added oyster shell fragments to simulate original appearance of colonial mortar.

Architect: Perry, Shaw, and Hepburn   Contractor: Todd and Brown

[illegible]

Lime has been used universally for masonry since virtually the beginning of time. In fact, clay brick, stone and lime are the oldest building materials.

Attesting to lime's durability are such famous structures as the Egyptian Pyramids, Parthenon, Great Wall of China and Roman Coliseum. All were constructed with lime mortar as the cementing or bonding agent.

Actually, lime or lime-pozzolans were the first cementing agents used in exterior construction. Many of the masonry buildings of Colonial America are still in good condition after 200 years of continuous service.

Unfortunately, too many people see only the obvious—not realizing that the mortar is really the life-line of any structure.

[illegible] ideal mortar

workability

Lime makes mortar highly plastic and workable, enabling the mason to fill the joints completely without undue effort, resulting in better quality workmanship. Mortar that is high in lime spreads easily under the trowel, increasing productivity.

water retentivity

Plastic, workable lime mortars have high water retentivity, which means that such a mortar retains its water and resists suction or absorption by the masonry units. A mortar with low water retentivity loses its moisture rapidly through absorption and "pancakes" or stiffens so quickly that intimate contact is not made with the unit.

Generally, as the lime content of mortars is increased, the water retentivity increases correspondingly. High water retention also minimizes the need for retempering the mortar.

bond strength

A mortar that fills joints completely will obviously produce more intimate contact with the masonry unit. As a result, it develops a better and stronger bond.

This kind of mortar also tends to "squish" into the interstices and irregularities of the masonry unit, providing a "keying" action which strengthens the bond.

Lime sticks to and works into the rough masonry surfaces, producing a tight mortar bond, which is the greatest possible prevention against leaky masonry.

However, bond strength has no relation to the crushing or tensile strength of mortar.

ideal strength

The right mortar should possess adequate compressive and tensile strength with a substantial safety factor. Limit to the amount of strength desirable is 750-1000 p.s.i. (compressive strength) in 28 days. Thus, the strength of a mortar can be an illusory criterion of its quality. According to the Bureau of Standards (N.B.S. Circular No. 30), a mortar of 100 p.s.i. compressive strength can support a brick wall nine stories high. Therefore, by using a 750 p.s.i. mortar, the safety factor would be 7.5:1. Mortars stronger than 750-1000 p.s.i. become progressively more rigid and brittle which can be detrimental to good masonry.

Mortars should set with reasonable speed to enable construction to proceed with minimum delay. The addition of portland cement to a lime-based mortar provides the necessary acceleration of strength.

elasticity and flexibility

A mortar of modest but adequate strength (500-1000 p.s.i. range) has far greater elasticity than brittle mortars that are stronger and harder. High lime mortar resists deflection (wind-sway) and lateral pressures better with less cracking in bond between mortar and units. Thus, a strong intimate bond characterized by high lime mortars tends to "give a little" under stress.

volume change

There is less volume change (shrinkage) with mortars of lower but adequate strength. Hard, high-strength mortars tend to shrink after hardening, producing separation cracking between the mortar and units, resulting in a loss of bond. Of all cementitious materials, lime possesses the least volume change.

autogenous healing

The ability of a mortar to reknit itself if voids are present or if small cracks develop between the mortar and the masonry unit is called *autogenous healing*. High lime mortars have this characteristic.

Nature provides this cure by rain water and atmospheric carbon dioxide. Hydrated lime, which is very slightly soluble, will dissolve and is recarbonated by the carbon dioxide. Gradually, this chemical reaction (similar to the formation of stalactites) plugs the crack or interstice.

efflorescence

The two prime causes of efflorescence are the improper protection of masonry units in walls under construction from rain or snow, and the presence of soluble salts (chlorides and sulphates) in the masonry materials. To protect the masonry units use a high lime mortar to provide tight joints and prevent the entrance of water. Thus, the water cannot act as a catalyst and dissolve the salts which later dry and crystallize as the unsightly "building bloom."

It is a chemical fact that lime contains less soluble salts than any other masonry material. However, regardless of the mortar used, masonry units and walls under construction should be covered with tarpaulins to prevent absorption of rain water.

weather resistance

A mortar should be durable and able to resist high winds, freezing, thawing, wetting and drying cycles. Lime-based mortars increase in strength steadily over a period of many years. Actually, wetting and drying cycles are beneficial to such mortars and tend to accelerate this gain in strength. Under freezing conditions the tight mortared joints prevent entrance of water and the disruptive effect of subsequent ice crystals in the wall.

economy

A mortar should be economical to use. In addition to being relatively inexpensive, lime has the greatest sand carrying capacity of any cementitious material. This means by virtue of its high plasticity, lime can accommodate a high percent of sand and still be workable—as much as 1:4½. In addition, there is less mortar wasted by droppings because of its tendency to stick to the units. Its slow setting characteristic also offers economy by minimizing retempering. Due to high workability, there is low labor cost in mixing and brick laying. Finally, high lime mortars are durable and require a minimum amount of maintenance.

technical data

For all around utility, ASTM Types N, O or K are recommended. Mortars should be prepared according to Tentative Specifications for Mortar for Unit Masonry (ASTM C 270-68), as given in the table below:

STANDARDS	PROPERTY SPECIFICATIONS		PROPORTION SPECIFICATIONS		
Mortar Types	Flow after Suction Minimum Percent	Minimum Ave. Comp. Strength p.s.i. 28 days	Parts by Volume Portland Cement (1)	Parts by Volume of Hydrated Lime or Lime Putty (2)	Aggregate, Measured in Damp, Loose Condition (3)
K	70	75	1	over 2½ to 4	Not less than 2¼ and not more than 3 times the sum of volumes of the cement and lime used.
O	70	350	1	over 1¼ to 2½	
N	70	750	1	over ½ to 1¼	
S	70	1800	1	over ¼ to ½	
M	70	2500	1	¼	

NOTES

(1) Portland cement: To comply with ASTM C 150 (Type I, II or III), or C 175 (Type IA, IIA or IIIA).

(2) Lime: To comply with ASTM C 5 (Quicklime for Structural Purposes) or ASTM C 207 (Hydrated Lime for Masonry Purposes—Type N or S).

a. ASTM C 5 covers all classes of quicklime, requiring a minimum of 95% calcium and magnesium oxides. It must always be slaked before use, by adding water. After slaking has ceased, add part or all the sand required, and store for a minimum of 24 hours.

b. ASTM C 207 also requires a minimum of 95% calcium and magnesium oxides (non-volatile basis). The residue retained on a 30-mesh sieve shall not be more than 0.5%, or if more than 0.5% shall show no pop or pits when tested in accordance with ASTM C 110. Type N (normal) and Type S (special) limes differ in the following ways:
(1) Type S has a plasticity of not less than 200 when tested within 30 minutes after mixing with water. (2) It has a water retentivity of 85% or more (Type N—75% or more), and (3) it has a maximum of 8% unhydrated oxides (Type N has no restriction on unhydrated oxides).

(3) Sand aggregate: to comply with ASTM C 144.

(4) Water used shall be clean and free from deleterious amounts of acids, alkalies, or organic materials.

(5) The mortar shall be mixed with sufficient water for a minimum of 5 minutes in a drum-type batch mixer (hand mixing may be permitted with approval of purchaser outlining hand mixing procedure).

mortar recommendations

1. *Above grade*—1:2:9—one bag Type I cement, 2 bags lime (or 2 1/2 cu. ft. quicklime putty), to not more than 9 cu. ft. sand.

2. *At or below grade*—1:1:6—one bag Type I cement, 1 bag lime (or 1 1/4 cu. ft. of quicklime putty), to not more than 6 cu. ft. sand.

3. *Specialized uses*
   a. Reinforced brick masonry—1:1/4-1/2:3-4
   b. Engineered brick masonry (for high rise)—1:1/2-1:4 1/2-6
   c. Chimney (not involving acid fumes)—1:2:5
   d. Glass block—1:1:4-5
   e. Ceramic tile—1:1:6

Blythe Park School, Riverside, Ill.

Mortar used was one part portland cement, three parts hydrated lime, and eleven parts sand.

Architect: Perkins and Will General Contractor: Chell and Anderson, Inc.

lime for stucco

For beauty and versatility, exterior plaster (stucco) buildings have been unsurpassed through the centuries. Now architects can blend improved stucco with modern design to provide colorful and functional buildings.

If the proper blending of materials is employed and if they are properly applied, plaster will provide a low-cost permanent method of facing homes and buildings. It is also widely used as a low-cost effective method of modernizing old residences. As in the case of masonry mortar, a good lime-cement plaster should contain an adequate amount of lime in order to provide elasticity, reduce shrinkage and cracking, improve workability—yet give sufficient strength. Since plaster is non-load bearing, it is unnecessary to use high strength, quick-setting mixes. In fact, more elastic stuccos containing adequate lime have excellent bonding characteristics. Moreover, unlike cement plaster, high lime stuccos offer architects the opportunity to develop bright colorful designs. Or, if desired, lime's whiteness can be an asset to either interior or exterior construction, aesthetically.

1. scratch coat

Use 1:1:5-6 mix (1 bag of portland cement, 1 bag of lime and 5-6 cu. ft. plastering sand). Hair or fiber may be added at the rate of 1 lb. per bag of lime. Apply a full, even 3/8" coat and when firm, scratch entire surface for good bond.

2. brown coat

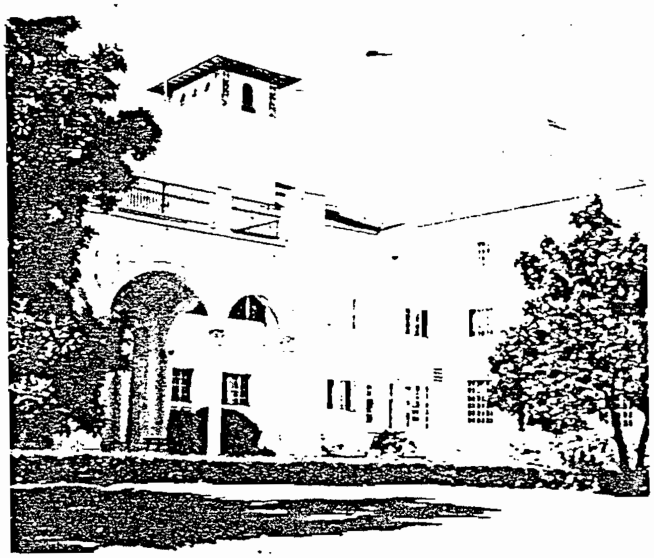
Use 1:2:9-11 mix. Hair or fiber may be added at the rate of 1/2 lb. per bag of lime. Apply 3/8" coat and use rod and darby to bring surface out evenly to grounds. Before surface is dry, broom to produce roughness for bond of finished coat. Moist-cure for one day and then allow brown coat to dry out for 5 to 6 days.

3. finish coat

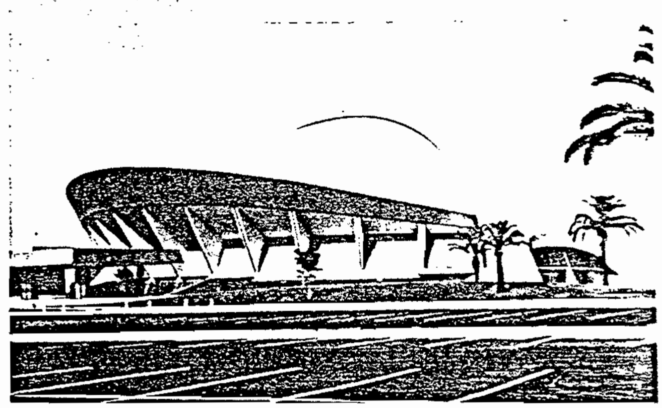
a. Sand-float finish—1:2:6-9 mix. Apply over well-set but evenly moistened brown coat in two even coats. Float to even texture, using wood, cork, carpet-covered or rubber float.

b. Smooth or texture finish—1:2-3 mix (cement and lime, respectively), either neat or with sufficient sand added for type of texture desired. Mix thoroughly and apply in two even coats and finish with tools according to texture desired.

In either case, the exterior stucco can be attractively colored with integral-lime proof oxide pigment or by painting.



Congressional Country Club, Bethesda, Md.—1964 National Open Course



Anaheim Convention Center, Anaheim, Calif.

All exterior plaster made with a lime-portland cement mix. Plaster areas include all soffits, fascia, paneling, plus the beams which form the large "A" extending from one side of the building to the other.

Architect: Adrian Wilson & Associates General Contractor: Del E. Webb Corp.
Plastering Contractor: Boone Plastering Co. of Los Angeles

From the standpoint of appearance, permanence, time-tested durability, fire protection, cleanliness, sanitation, economy and low maintenance cost, nothing excels the application of plaster for interior walls and ceilings. As in mortar and stucco, lime plays a key role in producing beautiful interior finish coats of superior quality and smoothness.

good plaster construction depends upon:

1. Use of proper materials
2. Correct proportion and mixing of ingredients
3. Application over proper backing
4. Good workmanship

Of paramount importance is the development of adequate bond between the various plaster coats—scratch, brown and finish (white) coat. For superior bond both the scratch and brown base coats should be scratched or scored before the application of the succeeding layer.

recommendations for finish coat

1. White smooth finish

Proportions—3-4½ volumes of lime putty* to 1 volume of gauging plaster. This is the equivalent of 100-150 lbs. of finishing lime to 50 lbs. of gauging plaster. For hard finish, use 50 lbs. of finishing lime to 100 lbs. of Keene's cement.

Application—mix ingredients thoroughly and first apply a thin coat over the entire scored brown coat. Then double back with second coat. Trowel to eliminate all checks, chip cracks and uneven points and bring to smooth even surface.

2. Sand-float finish

Proportions—2 parts by volume of lime putty, 1½ parts of Keene's cement and 4½ parts of sand.

Application—apply in two coats and bring to true, even surface.

3. Textured sand finish

Finish in same manner as sand finish except second coat is applied heavier and texture desired is obtained with cork, wood, rubber or carpet-covered float.

* Lime should comply with ASTM Designation C 6-49 (Normal Finishing Hydrated Lime) or ASTM Designation C 206-49 (Special Finishing Hydrated Lime) or ASTM C 5-59 (Quicklime for Structural Purposes). Differences between Type N and S hydrated limes are as noted in section on mortar.

stabilizing soils and expediting construction at building sites

Hydrated lime is increasingly used in *soils stabilization* for the construction of a stabilized subgrade, subbase, or base course for all types of roads, parking lots, loading areas, temporary haul roads, and to "beef up" the subgrade under concrete slab building foundations. Lime reacts with clay-bearing soils and gravels, stabilizing them against shrinkage and swell and hardening these soils by a complex cementing reaction. Thus, the addition of lime permits the use of submarginal granular materials and unstable clays and silts and obviates the need of undercutting and wasting these materials for replacement by often expensive, hauled-in base course and select borrow materials. 3 to 6% of hydrated lime, by weight, with 6 inches of in-place soil is a money-saver under many circumstances.

Hydrated lime also *expedites building construction* by drying up saturated building sites and haul roads so that construction equipment and delivery trucks do not bog down in the mud. Once lime is incorporated in the soil and compacted, the area or road does not revert to a quagmire in event of subsequent rains. Having 10 to 30 bags of lime on hand is good insurance to eliminate or minimize construction delays, particularly in late winter and spring or at the wettest times of the year.

Spreading lime on saturated clay sub-grade of warehouse.

Several hours later the sub-grade has dried out and is ready for compacting

about the national lime association

The National Lime Association, one of the oldest trade associations in the building and chemical materials field, was organized in 1902 to serve the manufacturers of burnt lime products. Its principal objectives are research, promotion and education on lime in its many fields.

N.L.A. Publications of Interest to Architects

Exterior Masonry Construction by Prof. Walter C. Voss
Masonry Brochure
Technical Notes on Mortar
Specifications for Lime and Its Uses in Plastering, Stucco, Unit Masonry and Concrete
Whitewash and Cold Water Paints
Lime on Lawns and Flower Gardens
Lime Dries Up Mud
Lime Stabilization Construction Manual
Lime in Asphalt Paving

Alabaster Lime Company
Ash Grove Cement Company
Austin White Lime Company
S. W. Barrick & Sons, Inc.
Bethlehem Mines Corp., Stone & Slag Division
Chemical Lime, Inc.
Cheney Lime & Cement Company
G. & W. H. Corson, Inc.
Cutler-Magner Company
Detroit Lime Company
Diamond Springs Lime Company
Dixie Lime & Stone Company
Domtar Chemicals, Inc.
The Dow Chemical Company
Florida Lime Corp.
Foote Mineral Company
GasprO, Ltd.
Great Western Sugar Co.
M. J. Grove Lime Div., The Flintkote Co.
Kaiser Aluminum & Chemical Corp.
Lee Lime Corporation
LeGore Lime Company
Pete Lien & Sons, Inc.
Limestone Products Corp. of America
Linwood Stone Products Co., Inc.
Longview Lime Co., Div. Woodward Co., Div. The Mead Corp.
Marblehead Lime Co., Div. of General Dynamics Corp.
Martin Marietta Corporation:
- Southern Cement Company Division
- Standard Lime & Refractories Division

McDonough Bros., Inc.
Mississippi Lime Company
National Gypsum Company
National Lime & Stone Company
Ohio Lime Company
Paul Lime Plant, Inc.
Pelican State Lime Co., Div. of Southern Industries Corp.
Pfizer, Inc.
- Minerals, Pigments & Metals Division

Rangaire Corporation:
- Batesville White Lime Division
- Texas Lime Division

Rockwell Lime Company
Round Rock Lime Companies
St. Clair Lime Company
Thomasville Stone & Lime Company
United States Gypsum Company
U. S. Lime Division, The Flintkote Company
Warner Company
The Western Lime & Cement Company

Dominion Lime (Div., Spancrete, Ltd.)
Domtar Chemicals Ltd.
Steel Brothers Canada Ltd.
Summit Lime Works, Ltd.
The Winnipeg Supply & Fuel Co., Ltd.

NATIONAL LIME ASSOCIATION
5010 Wisconsin Ave., N.W.
Washington, D.C. 20016
(202) 966-3418

PRINTED IN U.S.A.