# Lime as a Construction Material: Process & Application

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**ABSTRACT**

Lime has been used as a primary thing in masonry mortars for centuries and this vital use maintains to the present day in every ancient and present-day packages. Mortars made with lime and cement display off superior workability balanced with suitable compressive energy similarly to low water permeability and superior bond electricity. Lime is a primary constituent in outdoor and interior stuccos and plasters, enhancing the power, durability, and workability of these finishes. All of these lime packages are supported through ASTM specs and standards. Hydrated lime is an excellent, white, immoderate purity product specifically hydrated for handy, hassle-free use in mortar applications. It`s a unique product, with more stringent necessities for masonry typical overall performance than those imposed with the aid of using by other countries. Hydrated lime (precise Air-Entrained) is similar, except that it consists of an air entraining agent which produces minute voids in the blended mortar.

**Keywords -** Lime Mortar, Hydrated Lime, Non-Hydrated Lime, Surkhi.

1) **Lime**

Quick Lime **may be a** form of lime that is manufactured by the burning of stone that has calcium carbonate within it. The burning temperature varies, say 900 **degrees Centigrade** and above for several hours. This process **is named** calcination. The solid product **that is still** after the removal of carbon dioxide in the calcium carbonate is called the quicklime. CaCO3 (Calcium carbonate) –> CaO (Calcium Oxide – Quick Lime) + CO2


**Figure:1 Lime available from market (50kg bags)**

2) **The Exothermic reaction of lime after mixing in water (heat of hydration)**

The broad category of lime is non-hydraulic and hydraulic lime. The non-hydraulic lime is named quick lime, fat lime or white lime, or as lump lime. Hydraulic lime sets underwater and non-hydraulic lime doesn't set underwater. The fast lime is used as hydrated lime (quick lime with water). This is often because it is unstable and hazardous in nature. There's the heat liberated when a small quantity of water is added to the quicklime. After this hydration product, a fine dry white powder is obtained, which is named calcium hydroxide or slaked lime. Now, this process is defined because of the slaking of lime. The slaking of lime may be a process that varies depending upon the extent and type of use. For instance, the utilization of lime in plasters or mortars, and the use of lime in dry or putty form. Putty is made by the addition of a large quantity of water (two to three times its weight). This process promotes a reaction that makes the whole system boil. A semi-fluid mass is obtained as a stiffened mass on cooling, which is named putty. This material after proper screening is

employed as the material for construction. The fat lime or nonhydraulic lime doesn't set underwater, it sets with time. The hydraulic lime sets after the addition of water. This rate depends on the sort as well as the characteristic composition of hydraulic lime.

**Advantages of Lime in Construction**

- **Provides building breathing property–** the lime was considered material by the society for protection against the depletion of ancient buildings. This material lets the building be vapor permeable, thus allowing it to breathe. This reduces the probability of trapped moisture and damage to the building.
- **Renders Comfortable Environment–** Absorbing moisture by the lime, stabilizing internal humidity.
- **Ecological Benefits–** energy conservation than cement, small-scale production of lime is feasible
- **Protection of adjacent materials–** Porous texture of lime handles the moisture movement, without affecting the adjacent materials
- Provides good workability
- Durability is high
- Beautiful finish for the building
- **Self-healing properties–** Any movement of the building made from lime, creates micro-cracks. The presence of moisture makes the free lime active to precipitate and heal these micro cracks.

**3) The cementing Action of Lime**

The lime reacts with the carbon dioxide in the atmosphere to give calcium carbonate that gains cementing properties. This reaction is named carbonation. Hence the cementing action of lime depends on the rate of carbonation. For economical consideration, sand is incorporated into the lime mixture. This not only provides bulkiness to the mixture but also helps to form the mortar porous in nature. This hence would help in letting the CO2 freely circulate within them, to market carbonation. Another variation for this is often the addition of Pozzolana into lime. (Pozzolana, also referred to as pozzolanic ash, may be a natural siliceous and aluminous material that reacts with calcium hydroxide in the presence of water at room temperature). These are minerals with high reactive silica. These react with lime within the presence of water and the cementing compounds are formed. These, therefore, don't require any air to promote the reaction. Hence hydraulic lime is people who have reactive silica (Pozzolana) within it or added ones, that can set underwater.

**4) Slaking Process of lime:**

Generally, non-hydraulic or quick lime is employed for Slaking of lime. The process of blending lime in water is called slaking. The utmost temperature reached through the exothermic (heat producing) reaction of quicklime with water is a good indicator of the quality of the lime. The optimal slaking period of lime is 10 days. The mixture has got to keep stirring while mixing. The tank shall be filled to half its depth with water. Quick lime shall be gradually added till it fills the whole bottom to about half the depth of water. No part of the lime shall be allowed to expose above water level. Always lime is added in water, not water in lime because_

- Heat of hydration is fast, hot fumes and gases can cause injury while pouring direct water on lime. Slaking tank is usually constructed of cement and brick, due fast explosion tank may damage and water leakage may occur.
- Sometimes there are hairline cracks on masonry, dry lime may occupy these cracks and after adding water it expands into major cracks. So we always pour lime into the water.
- During the period of slaking of lime, it should be completely submerged in water (min.8" above lime) and keep adding the water. Initial 2 days there's continuous evaporation of water and the need to keep water adding till the heat of hydration gets end.
- This whole act has got to do with utmost precaution to the body by covering the eyes with glass goggles and wearing rubber boots.

**Figure 2: Figure showing the Slacking Process of Lime**

5) **Surkh**i

Surkhi is the powdered burnt bricks, and brickbats and is employed as an admixture to lime both for making lime mortar and lime plaster. Surkhi shall always be obtained from fully burnt or slightly below burnt, but never from over brunt bricks. The addition of Surkhi or other pozzolonas within the making of mortars gives the mortars the properties of hydraulic mortars i.e. quick setting properties.

**Figure 3: Surkhi as raw material**

**Figure 4: Grinding Machine process of making Surkhi**

**Preparation of lime Surkhi mortar**

**Mortar Mill-**

- **Traditional Mill**: During the early practice of lime mixing setup was done on the ground. In this process a circular pit (1.5'width and 1.5'depth) with a radius of 12'-15'. Marking center as turntable axis, wooden or M.S. member is attached with stone chikki which is rolled in the pit. This rotation of the wheel was practiced with help of bullocks/Camels and nowadays with Tractors.

- **Mechanical Mill:** Nowadays this technique has started used, to save time and productive purposes.

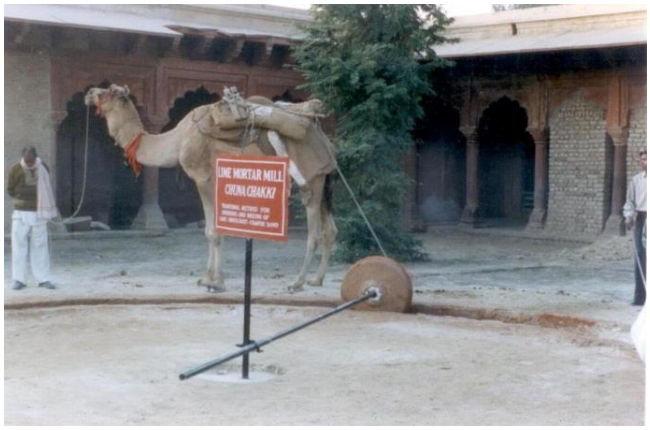


**Figure 5: Traditional lime mortar mill (camel)**

**Figure 6: Traditional lime mortar mill (Tractor)**

**Figure 7: Traditional lime mortar mill with adjacent slaking tank**

**Mechanical Mill:** Nowadays this technique has started used, in order to save time and productive purposes.

**Figure 8: Preparation of lime mortar (1:1:1) -1 Lime: 1 Surkhi: 1 Sand**

**Process:**
As per the given specification of mixture 1:1:1(lime: Surkhi sand) is prepared by mixing this component. Lime is hydraulic lime i.e. slaked lime in putty form.

**Natural Admixtures**:
The prepared lime mortar should be added with the filtered admixture of **Jaggery** water+ fermented methi, Javas (alsi) water/Bael Fal (***Aegle marmelos),*** this mixture is kept for fermentation 8 days before use. Mixing should up till required consistency depending upon the mode of grinding- Bullock-3hr, Tractor-1hr, Mechanical-30min. To check the consistency, the sample of mortar is thrown on the wall from 5ft and 75-80% should remain stuck upon the wall. The prepared mortar has to be then removed to a rectangular pit that would be used for storing of the mortar with enough space to allow the mortar to be mixed well for a short duration using feet before delivering it for application.

**Application**
The application of mortar is regular as cement plaster, manual or mechanical. Thickness can be achieved by 20mm-100mm with a different coat. Each coat should be of a maximum of 25mm thick simultaneously tamping should be done. The successive coat should be applied at intervals of 3 days while inspecting shrinkage and repairing, in this manner plaster can achieve maximum strength. Natural fibers like jute sun can be added for bonding if the thickness is high. Curing should be done after 24hr-48hrs depending upon the climate factor.


**Figure 9: Application of Lime Mortar at Conservation Project**

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