

# LIME AS CONSTRUCTION MATERIAL: PROCESS & APPLICATION

## Abstract

Lime has been used as a primary construction material for centuries in masonry mortars, and this vital use maintains to the present day in every historic & ancient sites. Mortars made with lime and cement display of superior workability balanced with suitable compressive energy very similar to low water absorbent and strong adhesiveness. Lime is a primary construction material in external & internal stuccos and plasters, enhancing the Structural strength, Aesthetics, and workability of the 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, more stringent and necessary for masonry typical overall performance than those imposed with the aid of using by other countries. Hydrated lime is homogenous, 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.

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1. **Lime:** Quick Lime is a configuration of lime which is produce by the removal of chemical component (calcium carbonate  $\text{CaCO}_3$ ) by heating process of raw stone. The heating temperature varies from  $900^\circ$  and above for several hours. This process is known as calcination. The solid product left after the removal of  $\text{CO}_2$  in the calcium carbonate is known as quicklime.

- The Chemical composition of Quicklime is defined a below:

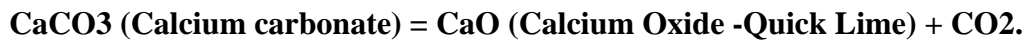


Figure 1: Lime available in market (50kg bags)

- **The Exothermic reaction of lime:** Lime is categorized in two forms non-hydraulic and hydraulic lime. Non Hydraulic lime: It is known by many names such as Fat lime, White lime, Quick lime, fat lime or lump lime.

The fat lime is used as hydrated lime quick lime with water (Hydrated Lime). Because it is unstable and hazardous in nature. During the process of making slake lime, lime is been mixed with small quantity of water and after the hydration process the fine dry powder is formed. Which is known as calcium hydroxide or slake lime. The fat lime or nonhydraulic lime doesn't set under water, it sets with time. Water is the key source of setting the lime such as, Hydraulic lime sets under water. The setting period of lime always depends on the characteristic composition of hydraulic lime.

- **Merits of Lime in Construction**

- Provides building breathing property– the lime was considered as a prime material which provides protection against the deterioration and depletion of the structure. It helps the structures to be vapor permeable, thus allowing to breathe. This reduces the possibilities of trapped moisture and prevents further damage of the buildings.
- Absorbing moisture by the lime, stabilize internal humidity.
- Ecological Benefits

- Protection of adjacent materials
  - Provides good workability as binding material.
  - Provides good structural strength and
  - Aesthetical smooth surfaces for the buildings.
- **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 as 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 CO<sub>2</sub> to freely circulate within them, to market carbonation. Another variation for this is often by the addition of Pozzolana into lime. (Pozzolana, also referred to as pozzolanic ash, may be a natural siliceous and aluminous material which 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, doesn't require any air to promote the reaction. Hence hydraulic lime is people who have reactive silica (Pozzolana) within in it, or added ones, that cans set under water.
  - **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. Optimal slaking period of lime is 10 days.

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 a part of the lime shall be allowed to expose above water level. Always lime is added into the water, not water into the lime.

- Heating process of hydration is fast, hot fumes and gases can cause injury while pouring direct water on lime. For the hydration process slaking tank is usually constructed of cement and brick, due to the fast explosion of lime under water, other material tanks may damage and water leakage may occur.
- Sometimes there is a hairline cracks on masonry, dry lime may occupy these cracks and after adding water in it expands into major cracks. So we always pour lime in 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 2days there's continuous evaporation of water and need to keep water adding till the heat of hydration gets end.



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

- 2. Surkhi:** Surkhi, also known as brickbats or powdered burned bricks, it is used as an additive to lime while creating the lime plaster and lime mortar. It is generally used totally or slightly under burnt bricks to make Surkhi; never use over burnt bricks. During Surkhi or other pozzolanic ash are added when producing mortar, the mortars acquire the characteristics of hydraulic mortars.



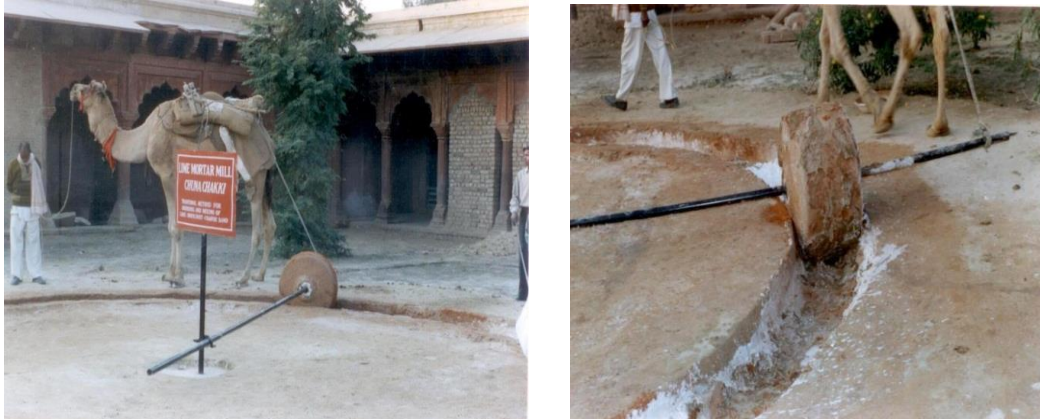
**Figure 3: Showing Surkhi as raw material**



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

## Preparation of Lime Surkhi mortar

- **Mortar Mill**



**Figure 5: Showing Traditional lime mortar mill operated by camel**

- **Traditional Mill:** During early practice of lime mixing setup was done on ground pit. In this process a circular pit of (1.5'width and 1.5'depth) with the radius of 12'-15' was created for churning of lime. Marking center as turntable axis, wooden or M.S. member is attached with stone chikki which is rolled in the pit. This rotation of wheels was practiced with help of bullocks/Camels, Tractors & Mechanical Equipment's.
- **Mechanical Mill:** Nowadays this technique has started using, in order to save time and productive purposes.



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



**Figure 8: Showing the Preparation of lime mortar- Ratio (1:1:1) -1 Lime: 1 Surkhi: 1 San**

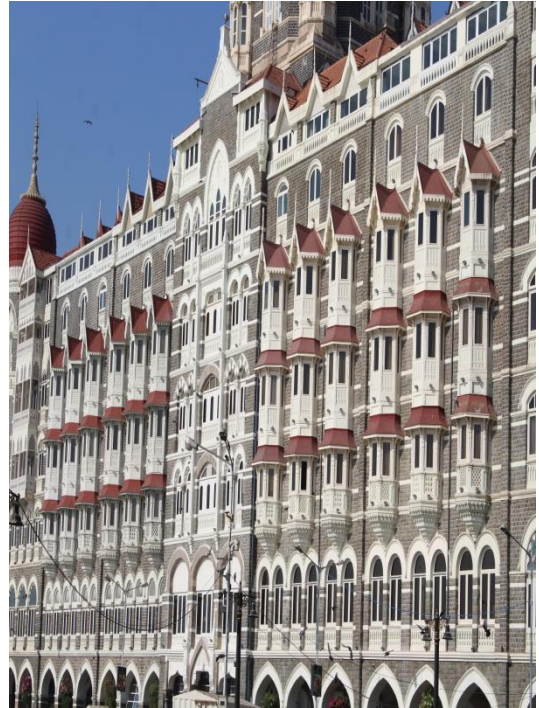
**Process:** As per the ratio 1:1:1(lime: Surkhi & sand) is Mix slaked lime is prepared in putty form for the external & Internal use of the buildings.

- **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 8days before use. Mixing should up till required consistency depending upon mode of grinding by Bullock-3hr, Tractor-1hr, Mechanical-30min. To check the consistency, sample of mortar should be thrown on wall from the distance of 5ft and 75-80% should be remain stick upon wall. The prepared mortar has to be then removed into rectangular pit mixed well before application to the structure or surface.

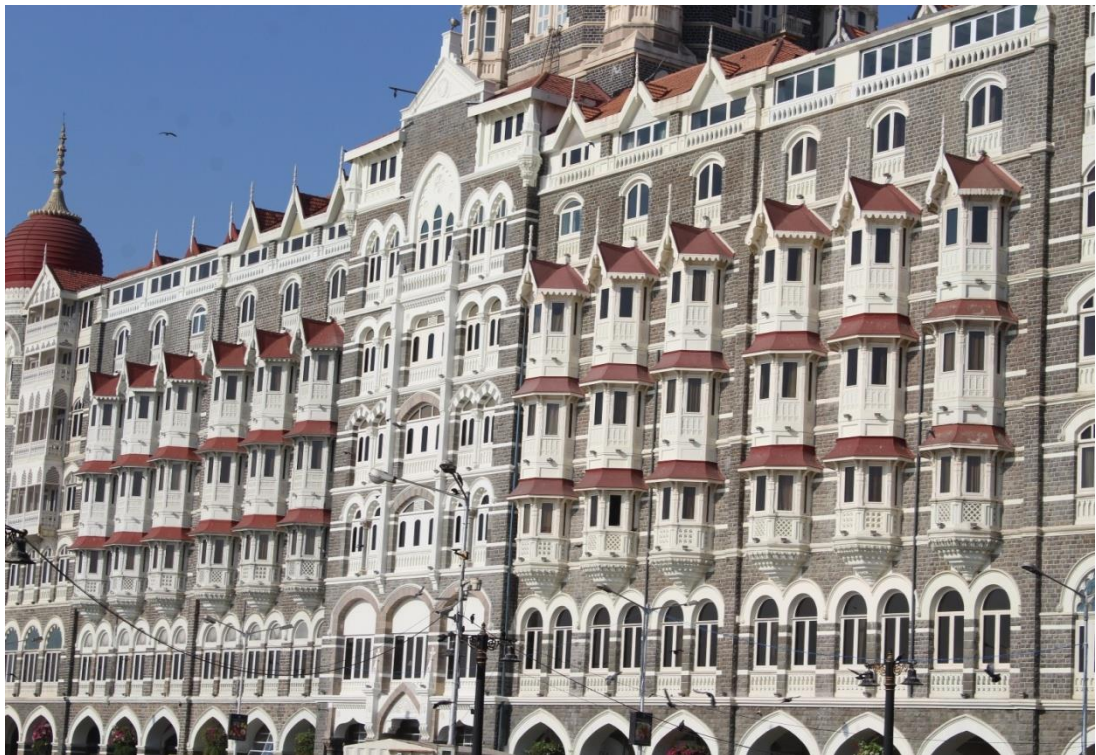
**Application:** Application of Lime mortar is regular as plaster, manual or mechanical. Thickness can be achieved 20mm-100mm with several coats. Every coat should of maximum 25mm thick simultaneously tamping should be done. Successive coat should be applied at interval of 3 days while inspecting shrinkage and repairing, in this manner plaster can achieve maximum strength. Natural fibers like jute sun can be added for better bonding if the thickness of plaster is high. Curing should be done after 24hr-48hrs depending upon climate.



**Before Lime Application**



**After Lime Application**



Source: savani heritage PVT .Limited

**After Lime Application : Hotel Taj Palace, Mumbai**



**Before**



**After**



**Before**



**After**



**Before**



**A fter**

Source: Savani Heriatge PVT.LTD

**Figure 9 : Application of Lime Mortar at site**

## **CONCLUSION**

The use of lime mortar is being accepted & applied around the world, initially it is driven by the aim to strengthen & provide the longevity to the structures. The Traditional Knowledge system played an important role in the journey of lime as building construction material. Today we can evidence the best and marvelous examples around the world standing from the centuries and portraying the physical and structural strength of the material and knowledge. The opportunities in the present condition for the use of hydraulic and pre-



formulated limes are endless, In future Lime can be the most precious and useful construction material for the construction industry.

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