Lime as Construction Material: Process & Application

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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 off 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 necessities for masonry typical overall performance than those imposed with the aid of using by other countries. Hydrated lime 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 is form of lime which is manufactured by removing the calcium carbonate by burning processor stone. The burning temperature varies from 900◦ and above for several hours. This process is known as calcination. The solid product left after the removal of CO2 in the calcium carbonate is known as quicklime. The Equation of Quicklime is defined a below:

CaCO3 (Calcium carbonate) = CaO (Calcium Oxide – Quick Lime) + CO2.

Lime available from market (50kg bags)

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

The wide category of lime is non-hydraulic and hydraulic lime. The non-hydraulic lime is known as quick lime, fat lime or white lime or as lump lime. Water is the key source of setting the lime such as, Hydraulic lime sets under water and non-hydraulic lime don't set under water. The fat lime is used as hydrated lime (quick lime with water). Because it is unstable and hazardous in nature. During the process of making slake lime, lime is been mixed with small quantity 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. 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 as a prime material protection against the depletion of ancient buildings. This material let the building to be vapor permeable, thus allowing to breathe. This reduces the probabilities of trapped moisture and the damage of the building.
- **Renders Comfortable Environment–** Absorbing moisture by the lime, stabilize internal humidity.
- **Ecological Benefits–** energy conservation than cement, small scale production of lime is feasible
- **Protection of adjacent materials–** Porous texture of lime handle the moisture movement, without affecting the adjacent materials
- Provides good workability
- High Durability
- Aesthetical smooth surfaces for the buildings.
- **Self-healing properties–** Any movement of the building made from lime, creates micro-cracks. Presence of moisture make 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 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 CO2 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.

4) Slaking Process of lime:

Generally non-hydraulic or quick lime is employed for Slaking of lime. 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 in water, not water in lime.

- 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's 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 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 showing the Slacking Process of Lime

5) **SURKHI**

Surkhi, also known as brickbats or powdered burned bricks, is used as an additive to lime while creating lime plaster and lime mortar. Always use totally or slightly under burnt bricks to make Surkhi; never use over burnt bricks. During Surkhi or other pozzolonas are added when producing mortar, the mortars acquire the characteristics of hydraulic mortars.

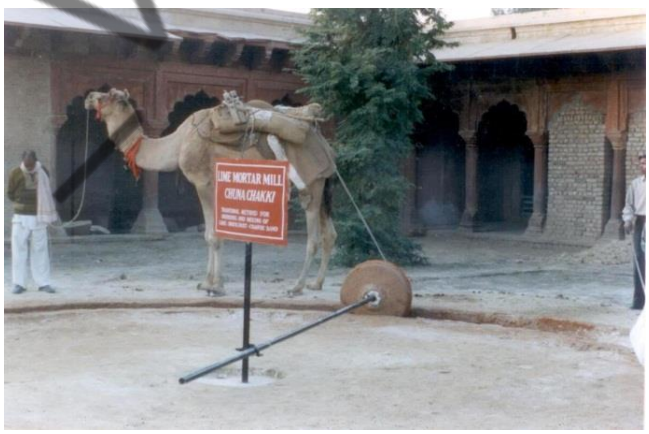
Surkhi as raw material

Grinding Machine process of making Surkhi

Preparation of lime Surkhi mortar

Mortar Mill-

- **Traditional Mill**: During early practice of lime mixing setup was done on ground .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 wheel 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.



Traditional lime mortar mill operated by camel

Traditional lime mortar mill operated by Tractor

Traditional lime mortar mill with adjacent slaking tank

Preparation of lime mortar (1:1:1) -1 Lime: 1 Surkhi: 1 San

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

Process:

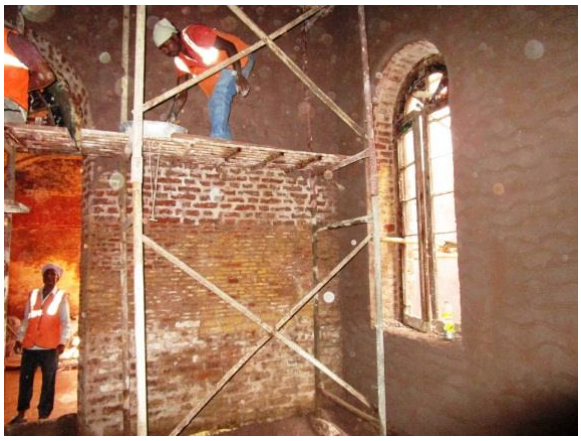
As per the ratio 1:1:1(lime: Surkhi & sand) is Mix slaked lime is prepared in putty form for the external & Internal use of the buildings.

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- Bullock-3hr, Tractor-1hr, Mechnical-30min. To check the consistency, sample of mortar is thrown on wall from 5ft and 75-80% should be remain stick upon 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

Application of mortar is regular as cement 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 bonding if the thickness is high. Curing should be done after 24hr-48hrs depending upon climatic factor.



Application of Lime Mortar at site

Conclusion:

The merits of lime mortars are being honored around the world, initially it is driven by the aim to strengthen & provide the longevity to the structures The Traditional Knowledge system plays 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, it can be the most precious construction material for the construction industry.

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