BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

BUILDING LIME

Introduction

There are a variety of building limes possessing different properties, utilized for different purposes and manufactured from raw materials of varying compositions. They are manufactured by the calcination of limestone, dolomite, kankar etc., in various types of kilns.

This digest describes the qualities of different building limes (excluding kankar lime), methods and the precautions required in handling and using them.

Classification

Building limes in general can be classified as :

(i) Eminently Hydraulic
(ii) Semi-Hydraulic,
(iii) Non-Hydraulic,
(iv) Magnesian and Dolomitic.

According to the Indian Standard Specification (I.S.712-1956) :

(i) Eminently Hydraulic limes are classed as A,
(ii) Semi-Hydraulic limes as B, and
(iii) Non-Hydraulic limes as class C limes.

Magnesian and dolomitic limes can be non-hydraulic, or hydraulic, depending upon the amount of siliceous and argilacious impurities present in the raw materials.

Eminently-hydraulic Limes and Semi-Hydraulic Limes

Eminently-hydraulic limes are used for structural purposes and for under-water works, while semi-hydraulic limes are normally used in mortars for masonry work. The raw material with a high percentage (20%) of clay like impurities containing silica, alumina and iron-oxide when burnt in the kiln, forms compounds with lime (Cao) possessing cementitious properties, which can harden under water. The proportion of these compounds determine the eminently hydraulic or semi-hydraulic nature of the lime. The ability to set under water is usually attained after two days by eminently-hydraulic limes and seven days by semi-hydraulic limes. Table I gives the specified chemical composition of eminently-hydraulic and semi-hydraulic limes

TABLE I

CHEMICAL COMPOSITION OF BUILDING LIMES (I.S. SPECIFICATION No. 712-1956)

S. No.	Constituents	Class A	Class B		Class C	
			Quick	Hydrated	Quick	Hydrated
1.	Calcium & Magnesium Oxide	60-70%	70% Minimum	70% Minimum	85% Minimum	85% Minimum
2.	Silica, Alumina & Ferric Oxide	25% Minimum	15% Minimum	15% Minimum	—	—
3.	Insoluble residue in hydrochloric acid less the silica	2% Maximum	3% Maximum	2% Maximum	—	—
4.	Loss on Ignition	—	5% Maximum (for lump lime) 7% Maximum (for ground lime)	—	5% Maximum (for lump lime) 7% Maximum (for ground lime)	—
5.	Carbon-dioxide	5% Maximum	5% Maximum	5% Maximum	5% Maximum	5% Maximum

Non-Hydraulic Lime

These are mainly used for finishing coat in plastering and white washing. Further, with the addition of surkhi or any other pozzolanic material, they can be used in mortars for masonry work. Pure limestone ($CaCo_3$) or pure dolomite ($CaCo_3.MgCo_3$) yield non-hydraulic limes which do not harden under water, but do so exclusively in air by recarbonation. Table I gives their specified chemical composition.

Magnesian and Dolomitic Limes

Magnesian and dolomitic limes are obtained from magnesian limestone or dolomite. Limestone containing 5-35% magnesium oxide yields magnesian lime, whereas dolomite yields limes with magnesium oxide content between 35-40%. These are mostly non-hydraulic, their slaking characteristics differentiate them from other building limes. In general they slake slowly with less generation of heat and volume expansion as compared to magnesia-free high calcium lime. They, however, yield harder setting mortar than pure high calcium limes. Great care is needed in slaking and gauging magnesian and dolomitic limes as they often contain over-burnt magnesia (periclase) some of which may remain unhydrated when slaked and gauged, and may later hydrate causing undue expansion and mortar failure. In view of this many engineers do not favour the use of dolomitic limes with cement mixes. It should be emphasised here that magnesian and dolomitic limes should be used only in completely slaked form in mortar mixes. The above care in slaking should be taken for hydraulic magnesian and dolomitic limes also.

Slaking of Lime

Non-hydraulic and Semi-hydraulic limes should be slaked with great care and attention to ensure proper hydration and avoid unslaked lumps. All extraneous kiln ash must be removed from the burnt lime before slaking and prevented from getting into the mortar or plaster. The performance of lime in mortar depends very largely upon the efficiency in slaking.

The main objective of slaking should be to obtain a completely hydrated product with maximum volume yield. Properly slaked lime consists of fine particle and settles slowly. Excess or deficiency of water should be avoided to safeguard against "drowning" or "burning" of lime; both the conditions result in producing an inferior quality lime with low volume yields. The use of very cold water or the uneven distribution of water is also undesirable. For best results lime should be freshly drawn from the kiln for slaking, preferably within seven days of its calcination.

The object of slaking, chemically speaking, is to form calcium hydroxide (slaked lime) from calcium oxide (kiln lime). Calcium hydroxide thus formed ready combines with carbondioxide from the air, forming insoluble calcium carbonate.

Methods of Slaking

Methods followed are :

i. Tank slaking
ii. Slaking by immersion
iii. Platform slaking
iv. Air slaking
v. Pressure hydration

Tank Slaking

It is applicable to non-hydraulic and semi-hydraulic limes only and is carried out in water tight box, tank or a pit. Two brick-lined tanks are constructed at different levels in such a way that the contents from the higher tank can flow into the lower tank by gravity. The slaking is carried out in the upper tank and the resulting milk of lime is run into the lower tank through a 1/8 inch (I.S. 320) mesh sieve. For best results, it is advisable to try a little of the lime lumps and observe its behaviour with water. Slaking has begun when pieces split off from the lumps or when the lumps crumble. Quick slaking lime takes less than five minutes while between five to thirty minutes are usually taken by medium slaking lime. Slow slaking limes usually take over thirty minutes.

For quick-slaking limes, the tank or pit is first filled with water which is two or three times the volume of lime to be slaked; lime is then added to cover the bottom of the vessel uniformly and to come to about halfway the height of water in the vessel. It is essential to add lime to the water and not the reverse. This will ensure the presence of sufficient water to satisfy the lime and prevent burning as a result of too little water. While the lime is being added, the mix is stirred taking care that no lime is is exposed to the atmosphere above the surface of the water at any stage. The mix is then allowed to boil gently, should it become violent, more water must be added immediately. It is, therefore, desirable to keep a plentiful supply of water available for such an emergency. As the mixture thickens, more water should be added with continuous stirring to obtain the correct consistency of the milk of lime. Stirring should be continued for ten to fifteen minutes after the boiling has ceased. The resulting milk of lime so formed should be screened through a 1/8 in. mesh sieve (I.S. Test Sieve 320) and allowed to mature in the lower tank for at least one week before use except in the case of semi-hydraulic lime, when the period of maturing should not exceed two days; throughout the maturing period, the lime putty thus formed should be adequately protected from drying out.

For medium slaking-limes, the tank or pit should first be uniformly filled with lime upto a depth of say 20 cm (6 to 8 inches), water should then be added on the lime so that lime is about half submerged. This will prevent the drowning of the medium slaking lime, i.e., excessive amount of water will not be available to the particles of quick-lime which begin to slake first. For medium-slaking lime, water in excess of the required amount should never be used.

Slow slaking limes should be ground to powder and then slaked as suggested for medium slaking limes. Warm water sometimes helps in hastening-up the process.

Precautions Necessary in Tank Slaking.

Precautions mentioned, below should be observed while slaking.

i. The lumps of quick lime should be of uniform size not bigger than the size of fist.

ii. The lime should be continuously stirred to break up the lumps and aid the slaking process with minimum cooling of the mix, as cooling retards slaking.

iii. Lumps of quick-lime should not be exposed to air during slaking and stirring, because when a partially slaked lump of lime is exposed to air, intense heat is generated which cannot be immediately transferred to surrounding water, and the steam thus generated forms an inert film of slaked lime on the unslaked portion, and prevents complete slaking. Further there will be considerable loss of heat which slows down the slaking.

iv. The lime pit should be preferably covered with boards or tarpaulin.

Slaking by Immersion

This method is generally successful for quick slaking limes. Lumps of quick lime are broken to the size of an egg and placed in a wire basket which is lowered in water and kept immersed till the ebullition starts, when it is withdrawn, thrown into a heap and allowed to disintegrate slowly. The main difficulty of this method is to get the workmen sufficiently experienced to hold the lime under water for correct duration of time.

Platform Slaking

It is applicable to all classes of lime and is usually carried out at site. It is carried out by sprinkling water over ~~lump~~ unslaked lime spread out on a platform to a thickness of say 15 cm. The total quantity of water used should be roughly one third the volume of unslaked lime taken for slaking and is sprinkled from the rose of a watering can from time to time until the lumps disintegrate to powder. As the water is added, the lime should be turned over and over with a showel or hoe. Slaking should be allowed to continue for a day and then the entire mass shifted through a 1/8 inch (I.S.320) mess sieve. It is then desirable to gather up the freshly slaked lime into a heap and cover it with moist sand, which is to be used in the mortar, and allowed to stand undisturbed for day or two to prevent escape of heat and allow the hydrated lime to mature.

Air Slaking

Fresh quicklime on exposure to air absorbs moisture slowly and disintegrates to powder without generation of much heat or increase in volume. It is then said to be air-slaked. Airslaking is not complete and is not at all desirable in building work, as it is very difficult to slake (hydrate) the partial air-slaked lime completely by any of the first three methods. Further, air-slaked limes are often contaminated with carbonated portions of lime.

Pressure Hydration

Pressure hydration is intended mainly to increase the plasticity of non-hydraulic limes and for magnesian and dolomitie limes, which are difficult to slake completely. It has been established that manegsian and dolomitic limes can be slaked best by saturated steam under pressure in special plants. Pressure hydrated magnesian and dolomitic limes are widely made and used in the U.S.A. and the U.K. but have not so far been manufactured or used in India.

Making Coarse Stuff or Putty for Hydrated Lime or Powder

Ready-made hydrated lime is not yet sold extensively. Some precautions are necessary while using it in construction. Hydrated lime is used either as putty or as coarse stuff. While using it the following should be kept in mind.

i. When used as a putty, hydrated lime should be added to the water to the consistency and thickness of cream and allowed to stand and mature for not less than sixteen hours before use. This ensures optimum yield and plasticity of the putty. The putty should be protected from drying out. Just before use the clear lime water standing at top should be syphoned off.

ii. When used as coarse stuff, it is first thoroughly mixed and ground with the required quantity of sand, water is then added and again mixed thoroughly. The mass is then kept for not less than sixteen hours to mature. Here again the mix should be protected from drying out.

Eminently hydraulic lime should not be run into putty form. In the case of semi-hydraulic lime, the putty or coarse stuff should be used up within two days otherwise its hydraulic properties will be partially lost. Putty or coarse stuff prepared from non-hydraulic limes can be kept for longer periods if protected from drying out. In fact, it actually improves with age.

Storage of Lime

Lump-quick lime should be slaked immediately after receipt as it takes up moisture and carbon-dioxide from the air and is reduced to inert gritty powder (Air slaked lime). This powder when subsequently slaked yields inferior quality of hydrated lime with low volume yield. If unavoidable, the unslaked quick-lime should be stored in multiwalled paper bags, having a water-proof lining. This is effective only against the entry of humid air, but not against direct contact with water. Hence, quicklime storage should be designed to prevent any accidental contact with water. Even under ideal storage conditions quick-lime should not be kept unslaked for more than a month. Where multiwalled paper bags

are not available, the best way to store lump quicklime is to keep it in a heap covered by dry air-slaked lime to prevent any air or moisture getting through to the main mass. The surface layer which is effected can be removed at the time of use, and can be utilised when dry to cover fresh arrival of unslaked lump lime.

The reaction between quicklime and water liberates enormous amount of heat accompanied with expansion. Hence in storing lump or grained quicklime there is always a risk of fire hazard.

Hydrated and hydraulic limes can be stored for comparatively longer period without much deterioration if kept in a dry place. It is preferable to store these in empty gunny bags in a dry store away from draughts and out of contacts with damp surfaces. Hydrated limes can be stacked as much as twenty bags high without injuring the bottom bag. In completely dry storage, hydrated lime can be stored for considerable periods without serious deterioration. However if there are any lump formations, it is advisable to screen the lime before use.

Simple Field Tests for Building Limes 3.1

Lime deteriorates on exposure to atmosphere and frequent checks at every stage e.g. storage, slaking, mixing is necessary to ensure of its quality. While this is fairly easy in a laboratory, simple field tests are available in the Code of Practice for Field Testing of Building Lime and Lime Mortar (I.S. 1624-1960). Copies of this Code can be had from the Indian Standards Institution, 9-Mathura Road, New Delhi.

Precautions in the Handling of Lime 3.2

Unslaked lime particles and freshly slaked lime can produce skin burns. It is therefore advisable to oil the skins daily and in addition to use goggles for protection of eyes.

There is a demand for short notes, summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need this Institute will bring out a series of Building Digests from time to time and the present one is the eighth in the series.

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