Natural hydraulic lime mortars are more frequently being used—not only in the repair of historic structures, but in new ones also.)

Pozzolanic Lime: Pozzolans are defined as materials which, though not cementitious in themselves, contain constituents which will combine with lime at ordinary temperatures in the presence of water to form stable insoluble compounds possessing cementing properties. Natural pozzolans are materials of volcanic origin. Artificial pozzolans are mainly products obtained by the heat treatment of natural materials, such as brick dust, fly ash, rice hull ash and china clay.

Non-hydraulic Lime: This is lime (less than 95% calcium hydroxide) made by hydrating or "slaking" the quicklime of relatively pure limestone, which hardens by "carbonation". Two forms are available:

Lime Putty: Ordinary (non-hydraulic) lime produced by slaking fresh quicklime in an excess of water to form a putty. Intense heat is created in the process and because of the danger involved, specialist training is required. Lime putty is matured for at least three months (the longer the better) in pits or under a thin film of water to prevent carbonation, and during this process the lime crystals change shape, becoming smaller and flatter, thus aiding workability.

Lime putty mixed with sand and hair was commonly used for internal plastering. For this purpose it was sometimes gauged with gypsum plaster. If non-hydraulic lime and sand mixes were used externally, a pozzolan was commonly added to increase its set and resistance to frost. Non-hydraulic lime and sand mixes are generally not suitable for modern thin wall construction.

Dry Hydrated Lime: Ordinary (non-hydraulic) lime produced as a dry powder by hydrating the quicklime with just enough water to convert the calcium oxide to calcium hydroxide. Also known as "bagged" or "masons" lime, it was developed to increase the workability of cement and sand mixes.

"Site-Batched" Lime Putty: The simple way of making lime putty is to add 5 gallons of water to one bag (50 lbs.) of dry hydrated "type S" lime. The sooner the lime is obtained after it leaves the kiln, the better the lime putty will be. Hydrated lime that is six or more months old, or lime that has been improperly stored, or lime in a broken bag should not be used.

A minimum of 24 hours will produce a wonderfully behaving lime putty with which to mix mortar. This is easier said than done though, as considerable care has to be given to proportioning, mixing procedures, moisture content of materials at the time of mixing, curing and other factors.

SO, HOW DOES ONE CHOOSE WHICH MORTAR TO USE ON A GIVEN PROJECT?

The Appendix of ASTM C-270 developed in 1951, provides a reference to which mortar type should be used in some general applications. A synopsis of this is:

Exterior, above grade: (Load-bearing wall, Non-load bearing wall, Parapet wall) Type "N".
Exterior, at or below grade: (Foundation wall, Retaining wall, Sewers, Pavements, Walks, and Patios) Type "S" or "M".
Interior, load-bearing wall: Type "N", "S" or "M".
Interior non-load bearing wall: Type "O" or "N".

These ASTM recommendations are based on newer construction standards and the philosophy of "stronger, harder and denser is better". What is not shown in these recommendations is the necessity of incorporating multiple expansion joints throughout the structure (commonly at 20 foot vertical intervals and one at each floor level) to accept the movement that the mortar cannot due to its rigidity.

The fallacy of compressive strength requirements: This staircase enclosure weighs 112,000 pounds (56 tons). It is 10 feet in diameter and 25 feet tall with 1 foot thick walls (a total footprint of 31 square feet or 4464 square inches). Therefore, the total load at the silo base is only **25 lbs. per sq. inch**. Clearly, Type M mortar at 3500 psi, Type S at 2448 psi, and Type N at 1245 psi are excessively strong.

These expansion joints (which are, it must be said, frequently insufficient to accommodate movement) are then sealed with caulking compounds that have a maximum life expectancy of 20 years, which makes no sense when the potential durability of a properly mortared structure would be 100 years or so until overall maintenance of the mortar is required.

Lime mortars have shown impressive durability expectations over 3,000 years of use in masonry construction, while modern mortars have proven to be less durable during the 100 years in which they have been used, and they are still being modified and understood.

We have been given multiple choices of mortar for our masonry work. One way is to get it done quickly, i.e. using quick setting modern Portland cement based mortar. Another is to use a more 'green' construction material such as lime mortar, which may slow down our building process but give us an environmentally friendly and long-lasting mortar.

THE DECISION IS OURS. REMEMBER, WHEN WE USE LIME MORTAR, HISTORY IS ON OUR SIDE. ■