Natural Hydraulic Lime - Materials Information Sheet

BUILDING MATERIALS INFORMATION SHEET 2

NATURAL HYDRAULIC LIME (NHL)

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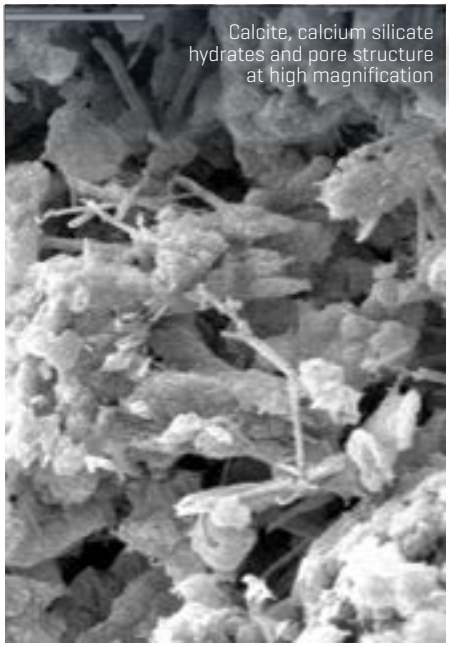
Summary

Natural hydraulic lime (NHL) is a binder that was commonly used for many construction purposes until the early 20th century. Today, it has had a significant resurgence, partly due to its favourable performance for traditional applications compared to Portland cement.

Composition and performance

NHLs are produced by burning impure limestone; they principally include calcium carbonate and can also contain silica and aluminium. The higher the level of impurities such as silica, the higher the amounts of hydraulic compounds formed during burning, and it is these that are mainly responsible for the strength of the material. NHLs are available in three classifications: NHL2, NHL3.5 and NHL5, with the higher numbers indicating greater strength.



Calcite, calcium silicate hydrates and pore structure at high magnification

Products known as hydraulic limes (HLs) and also formulated limes are available, but these are quite different to NHLs, inasmuch as they are artificially derived blends of various binder components and often contain cement as well (see BS 459 definitions). No indigenously sourced NHLs are currently available in the UK, although the import of French, German and Portuguese NHLs provides some choice in specification and procurement.

NHLs have relatively favourable performance characteristics, such as high permeability and flexibility. They must be set in context with cement mortars that are inherently less permeable and flexible. Generally, the higher the strength of the NHL binder, the lower the permeability and flexibility of the material. Compressive strength is in the range of 2–5MPa after 28 days, but continues to develop for considerably longer, and the upper limit for long-term strength in an NHL5 can be 10MPa or more.

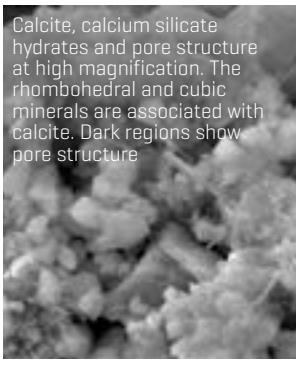
Identification and application

NHL is used for mortars, renders and harls, limewashes, and specialised products. The major use of NHL is in wall construction, with bedding and core mortars, external pointing, renders and harls for external surface finishes being common applications.

NHL sets and hardens by two simultaneous chemical reactions, hydration – a reaction of hydraulic compounds on contact with water – and carbonation of the calcium hydroxide – that is, the reintroduction of carbon dioxide into the binder.

These setting mechanisms yield stable mineral forms known as calcium silicate hydrates and calcite respectively. NHLs can set partially in damp conditions, but the lower strength NHL2 sets largely as a result of carbonation and is therefore unsuitable for prolonged damp situations.

Decay and degradation



Calcite, calcium silicate hydrates and pore structure at high magnification. The rhombohedral and cubic minerals are associated with calcite. Dark regions show pore structure

Durability is related in part to the suitable formation of the products of hydration. The materials must therefore be cured effectively, which is why after-care is fundamental to good lime works.

Defects in NHL materials can be subdivided into two main categories: during construction, early placement and curing; and in longer-term deterioration processes. The former are a result of frost damage, lime leaching, poorly graded aggregates leading to shrinkage cracking, and poor curing regimes causing rapid dehydration.

Longer-term defects are meanwhile caused by frost and salts associated with surface erosion and spalling. Life expectancy is a function of the climatic exposure level, the driving rain index and the conditions to which the element being constructed or repaired – e.g. a chimney or exposed or sheltered wall – will be subjected.

Additional data sources
Allen, G., et al. (2003) *Hydraulic Lime Mortar for Stone, Brick and Block Masonry*. Dorset: Donhead.
BSI (2010) *BS EN 459-1: Building lime. Definitions, specifications and conformity criteria*. London: BSI Group.
Forster, A. M., and Carter, K. (2011) "A framework for specifying natural hydraulic lime mortars for masonry construction". *Structural Survey* 29: 373–96.