

Castle Natural Hydraulic Limes offer a range of feebly (NHL 2), moderately (NHL 3,5) and eminently (NHL 5) hydraulic lime produced to meet the requirements for mortar, render and plaster for conservation, restoration and new build construction. They meet the requirements of BS EN 459-1 : 2001 type NHL Natural Hydraulic Lime strength classes 2, 3,5 and 5.

They provide a range suitable for use in lime: sand mortars for stone, tile, brick and block laying, external rendering and internal plastering. They provide options for the whole range of climatic conditions encountered in the UK. They are particularly useful in designing mortars and renders to complement the strength of natural stone and soft brick construction. The high degree of whiteness facilitates production of quality architectural finishes and can be pigmented to supplement sand colours and provide matches for restoration work.

### Applications

Castle Natural Hydraulic Lime as a constituent of lime: sand mortars can be used for a wide range of applications for jointing mortars, bedding tiles, renders and plasters. Using suitable sharp sand the mortar will have excellent workability and good water retention when applied to most bricks, blocks and surfaces to be bedded, rendered or plastered. The lower strength of natural hydraulic lime mortar compared with Portland cement based mortars allows mixes to be produced which complement the lower strengths of many natural stone and soft brick applications whilst improving plasticity and retaining a high level of cohesion with low shrinkage.

Castle Natural Hydraulic Lime mortars have excellent resistance to sulfates in either ground waters or in masonry. NHL 3,5 and NHL 5 mortars of lime: sand ratios of 1: 2½ and 1: 2 have good resistance to freezing and thawing actions.

### General guide to mortar selection by building application

Building element	Hydraulic Lime Mortar Designation
Internal walls	HLM 0.5
External walls	HLM 0.5 – 2.5
Facing to solid construction	HLM 1.0 – 2.5
Walls close to/below ground	HLM 2.5 – 3.5
Parapets, sills, lintels and cornices	HLM 2.5 – 3.5
Copings and cappings	HLM 2.5 – 5.0
Chimneys	HLM 3.5 – 5.0
Earth retaining walls	HLM 3.5 – 5.0
Masonry below water level	HLM 5.0

#### Notes:

Selection of mortar should take into account any structural requirements and the properties of the masonry units.  
The mortar designation (see following table for individual mixes) is for average exposure conditions. Selection must take account of any special local environmental considerations such as prevailing wind, frequency of frosts, location (coastal, hill-side, protected), etc.

### General guide to selection by hydraulic lime mortar designation (HLM)

HLM designation	Castle NHL 2 (lime: sand) by volume	Castle NHL 3,5 (lime: sand) by volume	Castle NHL 5 (lime: sand) by volume	Mean compressive strength (MPa @ 91 days)
HLM 5.0	-	-	1: 2	5.0
HLM 3.5	-	-	1: 2½	3.5
HLM 2.5	-	1: 2	1: 3	2.5
HLM 1.0	1: 2	1: 3	-	1.0
HLM 0.5	1: 3	-	-	0.5

#### Notes:

When selecting for mortar strength the effects of sand properties and the water content of the mix should be taken into account.

Technical guidance on the selection of binders for mortars and renders is available on request (see Castle Lime Putty, Castle Hydrated Lime and Castle Masonry Cement technical specification sheets). Further advice is obtainable from Castle's Technical Helpline on 0845 722 7853.

### Quality

Castle Natural Hydraulic Lime is produced from the natural argillaceous limestone deposits in the quarries at the Izaourt and Sauveterre Works of SOCLI in the South of France. The Quality Control at the works is backed by the extensive central Research and Development facilities of the Calcia Division of the Italcementi Group ensuring a high degree of consistency in performance and colour.

### Strength

Very high strength is not normally required of building mortars. An unnecessarily strong mortar will concentrate the effects of any differential movement between the mortar and the brickwork and cracks may appear which could reduce the durability and increase the risk of penetration by rain. A weaker mortar will accommodate some differential movement between the mortar and the brickwork and if cracking does appear it will generally be distributed as hairline cracks in joints, thus preserving the integrity of the stone, bricks or blocks themselves. In general the mortar should be weaker than the masonry units. The use of natural hydraulic lime mortar imparts special properties to mortar of low shrinkage combined with elasticity and allows cracks to heal autogenously by continuing carbonation.

### Mortar mix design

Natural hydraulic lime mortars gain strength by a combination of hydraulic action and carbonation. It is essential to consider the mix proportions of mortars with care. The following mix proportions provide a guide from which a mix can be selected to suit the construction and local environmental conditions. Other factors, such as the type of brick or stone, or the sand being used will affect the final mix selection.

Table of standard mixes per 25kg bag of natural hydraulic lime

Composition by volume (lime: sand)	Sand content (15 litre buckets/ bag of lime)	Water addition approx (litres)*	Yield (m <sup>2</sup> /bag)	Castle NHL content (kg/m <sup>3</sup> )
<b>Castle NHL 2</b>				
1: 2	6	18	0.10	260
1: 2½	8	21	0.12	215
1: 3	10	23	0.14	180
<b>Castle NHL 3,5</b>				
1: 2	6	14	0.09	275
1: 2½	7	18	0.10	245
1: 3	9	20	0.12	205
<b>Castle NHL 5</b>				
1: 2	5	14	0.08	310
1: 2½	7	16	0.10	255
1: 3	9	20	0.12	215

\* Water addition to mortar will depend on the moisture content of sand, quantities in table assume a moisture content of 7%.

#### Notes:

For the purpose of gauging sand a heavy-duty 15 litre bucket should be used. Sand should be clean, sharp and free of foreign or harmful materials. When mix proportions are by volume care should be taken, if the sand is either dry or excessively wet, to allow for bulking.

Backgrounds should be damp before application of render and the work should be kept damp for at least 24 hours after application.

Work should only be undertaken when the ambient temperature is above 5°C and below 30°C. During continuing cold weather, i.e. 5 – 10°C, consideration should be given to increasing the NHL strength class or mortar designation.

New work should be protected from direct sunlight and strong wind. In cold weather cover new work to protect against frost, rain or snow. In hot or fast-drying weather cover new work and keep damp for at least 72 hours.

## Renders

Choice of suitable mixes for renders follows a similar process to that for masonry mortars. In this case the properties of the substrate must be considered. The choice of sand will also be affected by the kind of finish required with finer sands being necessary for some smooth decorative renders and plasters. The overall mix durability in relation to exposure details will be similar to that for masonry mortar.

### General guide to mortar for renders by substrate type

Substrate	Base coat	Finish coat	Castle NHL
Weak or porous e.g. soft brick	1: 2	1: 2½	NHL 2 – NHL 3,5
Medium	1: 2½	1: 2½*	NHL 3,5 – NHL 5
Impervious e.g. dense brick	1: 2½	1: 2½*	NHL 3,5 – NHL 5
Plasterwork	1: 2	1: 3 finish on 1: 2½ second coat	NHL 2 – NHL 3,5

\* Each successive coat should be weaker and/or less thick moving away from the substrate. This can be achieved by mix proportions, NHL strength class and/or thickness of coat.

## Mixing

It is essential that the lime is uniformly dispersed and that any fine agglomerations are broken down. The time of mixing will be controlled by the efficiency of the mixer. Roller-pan mixers and screed mixers have the most efficient action but simple tilting-drum cement mortar mixers can be used if a longer mixing time is allowed. If the job is sufficiently large use a mixer with a capacity for a full bag of lime.

The following sequence will be suitable for a tilting-drum mixer. When mixing wear protective goggles and water-proof gloves.

- Introduce half of the sand and add all of the lime, mix well for 2 to 5 minutes until a uniform colour is achieved.
- Stop the mixer and isolate the drive. Scrape down any material adhering to the back. Add the remaining sand and mix again for 2 to 5 minutes to get uniform dispersion.
- Continue mixing adding water slowly over at least 10 minutes and giving plenty of time for water to be fully incorporated. The mortar should be more like a dough than a slurry and the less water added to achieve this, the better the mortar performance will be.
- The longer the final mixing time the more workable (fatter) the mortar will be. Workability will be improved by allowing mixed mortar to stand for 15 minutes before re-mixing for a further 5 minutes. (In hot weather do not over-mix as water will be lost through evaporation).

## Admixtures

Admixtures may be used with natural hydraulic lime mortars, subject to any limitations imposed by the job specification. In particular the use of air-entraining admixture in mortars and renders exposed to severe frost can be particularly beneficial. It is recommended that trial mixes are produced to establish optimum dosage consistent with the required strength.

## Additions

Addition of pozzolanic materials can improve the hydraulic activity and performance in some applications of natural hydraulic lime mortars. Materials such as traditionally used crushed brick, Castle BS EN 450 Fly Ash, ground granulated blastfurnace slag or metakaolin may be used to increase the mortar strength designation. Addition of Castle Hydrated Lime or Castle Lime Putty will improve the mix plastic properties but reduce the mortar strength designation. It is recommended that trial mixes be produced to establish the optimum properties for a particular application.

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