BEST PRACTICE GUIDE

Hydraulic Lime Mortars For Building & Re-pointing

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1. GRADES OF HYDRAULIC LIME & NON HYDRAULIC LIME FOR BUILDING WORKS

BSEN 459 PART 1 gives details and performance standards for the grades of building limes in use within the EU and can be summarised as follows:

1. CL90 – Non Hydraulic Lime
2. Natural Hydraulic Lime (NHL) 2
3. Natural Hydraulic Lime (NHL) 3.5
4. Natural Hydraulic Lime (NHL) 5
5. Formulated Limes (FL) 2, 3.5, 5
5. Hydraulic Lime (HL) – the regulations allow this grade to include cement

The grading of the hydraulic limes refers to their strength therefore NHL 2 is the weakest and NHL 5 the strongest.
Strength and frost resistance can also be varied by altering the mix ratio, typically the ratios will range between 1 lime: 1.5 Sand to 1 lime: 3 Sand (by volume). Generally exterior hydraulic lime mortars will be 1 lime: 2 or 2.5 Sand.

a) Contact Singleton Birch for technical advice and assistance
b) Refer to the following books

1. 'Building with lime' by Stafford Holmes and Michael Wingate ISBN 1 85339547/1 Revised 2001. Published by Intermediate Technology.
2. Hydraulic Lime for Mortar for Stone Brick and Block Masonry. Published by Donhead, ISBN 1873394640.

In 1998, UK Government funded research into hydraulic limes began at the University of Bristol resulting in the publication of the second book listed above in 2003. To date this book remains the definitive reference to the performance of most hydraulic limes.

2. GENERAL PRINCIPLES FOR PREPARATION OF SUCCESSFUL HYDRAULIC LIME MORTARS

To obtain the best performance from lime mixes it is essential that the correct sand and lime to water ratios are used. This will include assessment of the masonry units, and in the case of mortars, assessment of the engineering design strengths required for the structure. For local building works when the same sands, stone or bricks are repeatedly encountered this should only take a few minutes. The factors which affect the strength of a mix are:

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1. The type of sand. Soft sands with fine circular grains make weak mixes. Sharp sands with angular particles including some 3 –4mm grit produce the strongest mixes.

2. The water content. Too much water will decrease the mixes strength by holding the grains apart thus leaving an open structure when dry .This effect can be dramatic because the mortar will crumble and allow frost damage.

3. The amount of binder. Generally the purpose of the binder is to hold the sand particles together and to fill the voids between the grains of sand.

4. The type of binder. The strongest binders are those using Portland cement. The weakest are those made from high calcium lime. In between are the hydraulic limes categorised into three groups: HL2: HL3.5: HL5 - prefixing the category with N (i.e. NHL2, NHL3.5 or NHL5) indicates a natural hydraulic lime with no additives. The prefix FL2 : FL3.5 : FL5 refers to formulated limes which are blends containing additives from a designated list.

2.1 Storage of Lime & Aggregate

Our Hydraulic Lime is supplied in 25kg paper bags which must not be allowed to become wet. Once opened the exposure to air will start to weaken the hydraulic set. As a result any opened part bags left at the end of the day should be carefully folded over at the top and put into a dry store. In this state the lime will remain useable for a further 2 or 3 days. Thereafter it should be discarded. For larger orders the individual bags will be supplied with up to 40 on a pallet.

Aggregate should also be covered since if left exposed fines can be washed out and the material as a whole .can gradually separate. The result will be to make the aggregate less well graded and this may impair durability of the mortar. Covering the aggregate will also stabilise the water content and make mixing more consistent.

2.2 Aggregate

There are many poor quality sands on the market. In most cases for good quality lime work -which is about better building, these soft fine sands, frequently containing clay, are not acceptable. Clean sharp, well graded sand should be specified. A good supplier should be able to provide a sieve analysis against which the sample sieve analysis provided (see the Fact Sheet Sharp Sand download) can be compared.

2.3 Sand Void Percentage

If you find a good local sand which you may use repeatedly, establishing a void percentage is a very worthwhile exercise. Working with unknown materials is not a good idea. Knowing the voids in the sand tells the user how much binder is required in order to fill the voids. Insufficient binder

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to fill the voids will weaken the material and make it vulnerable to frost damage. The procedure to find the void percentage is as follows:

1. Take a container of known volume (a one or two litre jug or jar is ideal) and fill it level to the top with the selected sand.
2. Remove the sand and dry it completely in an oven on a tray.
3. Replace it in the container to a level top.
4. Take a measured jug of water and gradually add the water until bubbles stop rising and the water has saturated the sand.

5. The void ratio is then:

$$\frac{\text{volume of water added x 100}}{\text{volume of sand}}$$

For Example: If the answer is 30%, then a 1 lime to 3 sand (by volume) will fill the voids.

In general the type of sands suitable for lime work will have a void ratio in excess of 30% probably 35- 40%. Therefore our general advice is to use a mix ratio of 1:2 or 1:2.5 in order to ensure adequate frost resistance.

2.4 Water Content and Masonry Units

The more water remaining in the mortar the weaker will be the final result. However too little water will also prevent necessary chemical processes taking place and weaken the material. The water absorption of masonry units with which the mortar is being used has a considerable bearing upon the final strength by altering the amount of water left in mortar.

Bricklayers and masons will normally add sufficient water to obtain adequate workability However if the tradesmen are not used to mortars with sharp sands it is possible that too much water may be added.

IT IS STRONGLY RECOMMENDED that either:
Manufacturers absorption figures are obtained for the masonry or the following test is carried out:
a) the brick/stone is oven dried and weighed
b) the brick/stone is then placed in bucket of water for 2 hours and then re-weighed

Water percentage in the masonry can then be established.

$$\frac{\text{weight of water added x 100}}{\text{weight of brick}}$$

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Optimum strength is likely to be achieved with a final mortar water content of around 15% by mass after suction of water by the masonry using a typical sharp sand with 36% voids.

2.5 Mixing Technique

A conventional cement mixer can be used although for larger projects a roll pan or paddle mixer is preferable. These are becoming more readily available on the market with the renewed interest in lime products. Measuring of material must always be with a gauging box or bucket. A shovel is not acceptable since quantities are too inconsistent.

Lime mortars mixed in drum mixers can be prone to balling but use of particular mixing techniques can reduce this. It is therefore recommended that the estimated quantity of water is put into the mixer and then turned on, then add approximately ½ the appropriate quantity of sand. The lime should then be added. The rest of the sand is added and mixed for not less than 15-20 minutes. Do not overfill the mixer as this will prevent proper mixing.

The mix, to begin with, should appear rather dry but as mixing time increases the mortar will become much 'fattier'. At the end of 20 minutes final water can be added to obtain the correct workability (if required). If too much water is added the risk of shrinkage will increase and the final strength will be reduced.

2.6 Use of Air Entrainment Agent

Use of air entrainment agents is not recommended.

2.7 Additional Pozzolan

In cold weather and for certain other applications it may be advantageous to add additional pozzolan in order to increase the speed of set and/or increase strength. It is recommended that the company be consulted as to the quantities of these materials to be added since the amount may vary depending upon the work being undertaken.

3. TECHNIQUES FOR MORTAR USE IN WALL CONSTRUCTION

Mortar Strength

For exterior work, when mortar joint size permits, the sand should contain a small proportion of 3-4 mm grit.

A 28 day compressive strength of 1.0 newtons/mm2 should be attainable with an NHL 3.5, provided average ambient temperature exceeds 10°C. Below this, the rate of strength build up may slowdown work. Additional strength requiring a 1:2 mix will be needed for the following areas of exposure:

- Chimneys
- Parapets

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- Copings
- Splash areas at base of walls
- Below DPC

The following points need highlighting for all mortar work:

1. The mortar should be very well mixed -balling must be avoided. Always measure using a gauging box or bucket.
2. Mortar must not be allowed to dry out too quickly. This is especially important with porous masonry that may require wetting before construction.
3. Mortar must be used within two hours and then left to set. It may be advantageous to brush the surface later the same day to expose the grit.
4. Do not use if the temperature is too low i.e. 5°C or below.
5. Be prepared to protect from frost, excessive sunlight and drying winds.
6. Pointing is kept moist for 7 days. The chemical set can only complete in the presence of water.

It should be possible to build at about the same rate as with Portland cement mortars but bear in mind
the mortar will continue to gain strength for up to one year although an adequate set will be achieved in a matter of a week or two.

4. PROTECTION & AFTERCARE FOR LIME MORTARS

4.1 Effects of Rain and Temperature

Without doubt often the most significant difference to the user between OPC and lime based mortars and renders is the rate of strength build up in cold weather. This can result in:

1. Slower rate of laying
2. Requirement for protection against water saturation and frost

In mild winter weather work with hydraulic lime mortars can proceed normally provided there is provision of immediately available protection in the event of rain and/or frost.

In order to understand the need for protection, specifiers and contractors should appreciate that the rate of set of hydraulic lime is more dependent on temperature than cement. While mortars laid in the summer months may achieve frost resistance in a month, work done at cooler times of the year will undoubtedly take much longer and will therefore require protection from frost longer too - perhaps for the remainder of the winter. Without doubt the worst combination is heavy rain followed by clear skies and a frost. Saturated walls with under-strength mortars will suffer frost damage much more easily than walls protected from the rain. Driving rain poses less of a risk than

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rain entering from the top of the wall. As a result covers on the top overlapping, say 300mm each side will do much to keep the wall dry thereby reducing the risk of damage.

Another factor to bear in mind relates to porosity of masonry units. Porous materials hold very large quantities of water. Lime mortars are designed to aid evaporation. This process of evaporation causes a drop in temperature, so the mortar in new walls holding large quantities of water will set slower because of this drop in temperature. A great deal of the water in the masonry units will evaporate out through the mortar joints. This effect will ensure a permanently low temperature in the lime mortar until the whole wall begins to dry. Cement mortars are much less permeable and a high percentage of the water will have to evaporate from the face of the masonry units.

4.2 Frost Protection

As stated previously wet masonry is much more vulnerable to frost. Frost protection of masonry is best achieved using Hessian or bubble wrap. During daylight hours if warming winter sum is available, covers should be lifted to allow heat to be absorbed and then replaced during late afternoon. Even under these conditions a circulation of air is advisable between covers and masonry.

5. ADDITIONAL FACTORS FOR REPOINTING EXISTING WALLS

The general factors affecting the preparation, use and after care already laid out in this section apply to re-pointing existing walls. However the following additional factors need care:

1. The joints must be raked out not less than 20mm
2. Once the joints are raked out, loose material should be brushed out and the joints wetted immediately prior to placing new pointing.
3. As the new mortar stiffens up it should be packed back hard into the joint before final finishing off.

It should be noted that in general, re-pointing work should not require any stronger hydraulic lime than Singleton Birch NHL 3.5. Exceptions may be very exposed positions e.g. chimneys, canal and sea defence works.

6. HEALTH & SAFETY INFORMATION

Safety Data Sheets are available to download.

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Disclaimer

Singleton Birch cannot accept any liability for incorrect use or application of Hydraulic Lincolnshire Lime. Recommended 'best practice' should be followed at all times.

If in doubt, please call us on Tel: 01652 686000 for advice or assistance.

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