

Protecting St Astier Natural Hydraulic Lime Mortar

A very important function of mortar in masonry work is to provide wind and watertight protection to walls, this is equally relevant to mortar joints and to rendered surfaces. Proper specification and application will ensure that the wall functions properly. It is essential therefore to ensure that new work, properly specified is allowed to cure from its wet application state into a fully functioning mortar. To assist in this process adequate protection must be given to mortars during and after their application until the mortar is sufficiently cured to perform its designated function.

Protection starts before the work takes place: it is important to assess the state of the structure before work commences. Robust detailing, properly installed ground drainage, roof membranes, gutters etc should all be in working order to avoid water ingress and over saturation of fresh mortars.

During and after application, protection should be in place for as long as necessary for the mortar to firstly cure properly and then, dry sufficiently. The moisture content of the cured mortar should be measured before protection is taken down. As a general rule this should be about 8%.

Moisture, present in saturated walls, prior to the commencement of work should be allowed to dry out properly. In circumstances where this is not entirely possible, the mortar used should have the best possible void structure to allow the maximum evaporation to occur through the mortar. This may require a change in the mortar specification, either of the binder / aggregate ratio or the aggregates or both, and should be treated as a design consideration.

The use of well graded sharp sands with a good part of coarse content (10-15% of 4 or 5mm) will allow the moisture to pass more readily through the mortar and the wall to dry quicker.

Mortars, such as finished renders with finer sands, tightly finished, will reduce the vapour permeability. Best practice is to leave the face of the new work open and not closed tightly. In joint work it is recommended to stipple or scrape the face of the joint.

The exposure of the site to adverse weather conditions is also a major consideration in the design, specification, planning and execution of the work. The principle factors are:

Rapid drying caused by: direct sun, heat, wind

Insufficient drying caused by: excessive rainfall, low temperatures, humid/damp conditions.

Freeze Thaw action

Rapid drying:

If the mortar dries out too quickly, hydration and carbonation will be inhibited, drying shrinkage may occur and the mortar may become friable. Rapid drying is best avoided by screening against strong direct sunlight and provision of physical barriers to reduce wind action. A cost effective and simple method is to screen work with small sized mesh debris netting (double if necessary) or robust tarpaulins or heavy-duty plastic sheeting on the outside of the scaffold.

Seasonal aggravating factors are: hot weather, warm drying wind.

Insufficient drying:

If the mortar dries too slowly, water, held in the mortar will slow or diminish the rate of initial and possibly final set, inhibit carbonation and result in a mortar that is frost feeble. It may also be susceptible to lime migration, sufficient to cause friability in the mortar. Protection of the wall heads and functioning drainage should be in place.

Freeze Thaw action:

Can only occur if the mortar pore structure is saturated. If there is a danger of freezing of fresh or uncured mortar, close covering with hessian or tarpaulins and if necessary additional heating should be provided. Polythene should not come in contact with fresh mortar.

Planning and Budget for protection of new work:

Programming of works, particularly finished render requires careful planning as well as execution in addition sufficient resources should be included in the contract cost to provide the following. Scaffolding for all work should be capable of supporting temporary covers and project sufficiently above the works to afford protection at the wall heads or eaves. It should also allow sufficient working space for the application intended. Site storage must be available to keep materials in clean dry conditions, and sand stock piles should be kept on clean hard surfaces and covered to protect them from rain and frost. Where more than one sand is being used, these should be in separate piles.

* **Note: Late autumn, early spring & winter working** Cold wind or strong wind with low air

temperature will produce wind chill effects that will significantly reduce the surface temperature of fresh mortar. Due to the season and/or inadequate protection against rain or, indeed, if moisture is present due to saturated structures, the mortar might not be dry enough and therefore frost damage may occur.

Wind chill effect							
Wind	Temperature in C°			Wind	Temperature in C°		
Mph (m/sec)	+5	0	-5	Mph (m/sec)	+5	0	-5
	Wind chill effect				Wind chill effect		
4.3 (2)	2	-2	-7	26.7 (12)	-11	-16	-25
8.7 (4)	-1	-7	-12	31 (14)	-12	-17	-26
13 (6)	-4	-10	-16	36 (16)	-12	-18	-27
18 (8)	-6	-13	-20	40.3 (18)	-13	-19	-28
22.3 (10)	-10	-15	-23				

Rain Allowing mortars to be saturated by rain should be avoided for the following reasons:

- * Over saturated mortars can result lime leaching which, in severe cases, will affect the binder ratio with negative effects on the durability of the mortar. A typical example is if the mortar is too sandy when rubbed.

Light and not continuous rain, provided that frost is not forecasted, will help to cure the mortar and can be beneficial especially in warm spells. Heavy rain, especially if detailing are poor or wind driven will not allow the fresh mortar to dry sufficiently to withstand frost unless adequate protection is in place.

Frost - Water expands by about 9% of its volume when it freezes. In a closed container containing pure water, the critical saturation point is 91.7% of the total volume if there is less than 8.3% unoccupied space, then rupture of the vessel is likely as the water freezes.

It would be all too easy to equate the pores in the mortar to the closed container model, in which case you would need a saturation of less than 91.7% to protect against frost damage (equating to say, a free moisture content of <16.1% by dry mass), but in reality the situation for porous construction materials cannot be related to such a simple model, and although there is a critical saturation point, this is far less easy to determine, and depends on the individual material itself and its pore structure.

There are many complex factors involved. Some of them are:

- * The pore water contains dissolved lime and binder constituents, which depress the freezing point of the water.
- * Freezing is a gradual process, occurring from the surface of the render inwards.
- * As ice crystals form in one pore, the resulting increase in volume causes unfrozen water in that pore to be squeezed/expelled into adjacent connected pores, causing a progressive build-up in hydraulic pressure if those pores are also full of water.
- * As pure ice crystals form in one pore, solutes are transferred to adjacent unfrozen water, depressing the freezing point but causing local osmotic potential differences (with disruptive effects of osmotic hydraulic pressure as water flows into areas of higher solute concentration in an attempt to equalize the salt concentration)
- * The freezing point varies with size of pore due to variations in pressure, with highest pressure in smaller pores, thus freezing tends to start in larger capillary pores and extends to smaller pores.
- * Repeated cycles of freezing and thawing have a cumulative damaging effect.

The overall concern is that if the mortar is saturated with water, there is insufficient unfilled pore space to accommodate these effects, and the degree of resistance to frost damage is likely to be low as shown below:

Sample Ref Free Moisture Content (represents in-situ condition at time of sampling, expressed as % dry mass basis) Potential Moisture Content of saturated sample (based on moisture absorption @ 72 hours full immersion, expressed as % dry mass basis) % Saturation (a measure of how saturated the capillary pores were with water in the in-situ condition at time of sampling)

Sample Ref.	Free Moisture Content (represents in-situ condition at time of sampling, expressed as % dry mass basis)	Potential Moisture Content of saturated sample (based on moisture absorption @ 72 hours full immersion, expressed as % dry mass basis)	% Saturation (a measure of how saturated the capillary pores were with water in the in-situ condition at time of sampling)
A	17.1	17.6	97%
B	15.3	15.7	97%
C	13.9	15.3	91%
D	8.2	14.5	57%

The above Data is from a research conducted by Heritage Testing Ltd. in 2003.

The most effective protection against frost is to carry out work in the months where frost does not occur, but where this is not possible provide a scaffold construction with sheeting on the outside against rain/wind and hessian sheeting on the wall. Again attention should be paid to detailing, roof, drainage and gutters. The same applies in structures where moisture is coming from within.

Should it be necessary to continue work during the cold season, adequate heating of the structure should be in place together with the scaffolding system previously described.

Sun - Strong and direct sun can cause rapid drying and shrinkage. This effect could be aggravated in the presence of warm wind.

Scaffolds should have close knit debris netting on the outside to provide shade without impeding ventilation.

It is also recommended that, in warm weather and active drying conditions, the mortar is cured with light water mist 2 or 3 times a day to slow down any potential drying effect.

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