

1. Hello
2. Everyone knows lime mortar, you see it everywhere. Probably in the building you are hoping to repair under this grant
It is predominately white with big grits, often very soft and apparently failing. However you must remember that all the buildings built before around 1900 must have been made with lime mortar, most of which would have been made in Ireland out of Irish limestone burnt to make quicklime usually in a small local kiln. A soft mortar turns out to be ideal for these buildings.
3. Also here is some more lime mortar, sheltered under the eaves. Again very white and soft
4. Lime is made from Limestone which is burned or calcinated in a kiln. 850-1000 degrees C. The kilns used to exist all over the country. They look like this...
5. In the top is a round hole or pot. Here with a tree. The pot is lined with granite or other stone that will not burn. The pot was plastered on the inside with fireclay to make it last longer.
6. The pot is a cylinder with a funnel shape at the bottom. There is an access tunnel to the base of the funnel which was used to light the fire and control the draft. Also to get the lime out at the end.
7. This is the lime kiln at Russborough being filled with timber and limestone boulders. This kiln was fired in 2015 and you can see in the picture on the right that the lumps of stone are more or less the same during burning as they were going in. The kiln was fired with the ash tree that was growing out of it when the restoration of the kiln started.
The limestone boulders are probably from glacial till as the kiln is in Wicklow where there is no solid limestone, but there are deposits of sand and limestone pushed here by the glaciers of the past.
8. This is lump lime which is what comes out after the burning process is completed. It looks like the stones that went in, but is about half the weight. The stones are the same size as they started. Lump lime is quicklime or Calcium Oxide. It is highly reactive with water and produces considerable amounts of heat when water is added to it.
In the past this is what would have been delivered to the building site, or indeed burnt on site. Because moving materials around was difficult....
9. This was heavy transport..probably 300kg max??
10. Nowadays the lime kilns are not so romantic. This is Clogrennane near Carlow which is the only commercial lime kiln in Ireland at the moment. The lime burnt here is very pure and produces a non hydraulic lime. This means it sets only by a process of carbonation.
11. The bag in the trailer is quicklime from Clogrennane. It is available from Glanbia and other agricultural suppliers as Growmax and is used for liming fields to increase the ph. The bags are 375 Kg and there are four on a 1.5 ton pallet. The price is €70 inc VAT whilst a 25kg bag of NHL will cost you €17 or so That makes a ton of quicklime €200 and a ton of NHL around €680. The mortar made from Growmax is non hydraulic meaning it sets by the action of carbon dioxide from the atmosphere which is why it is called an air lime

The alternative to quicklime is Natural Hydraulic Lime or NHL which can be seen in the bags on the right. The process to make NHL is the same as for the Growmax but the limestone has impurities such as clays which cause the resultant lime to form a relatively fast initial set through chemical processes rather than by carbonation which is much slower. The NHL you buy is hydrated, which means it has been slaked at the factory so will not heat up when water is added. All available NHL is now imported from France, Germany or Portugal.

12. In the pan on the left you can see some Growmax kibbled quicklime. If you leave quicklime in the open it will 'air slake' using the moisture in the atmosphere to react to form hydrated lime. The same lime can be seen on the right after about three weeks in the air. You will notice it has swelled up to around 2 1/2 times the size. The kibbled lime fitted in the plastic ice cream pot on the left before it was slaked. What you cannot see is if you touch the slaked lime it would collapse into a fine powder.
13. Here is some chemistry! This is the lime cycle which shows how limestone is burnt to calcium oxide, slaked to make calcium hydroxide and then carbonated which brings it back to limestone again.
14. To make a hot mix, there are various methods. Some people make a donut of sand and add the quicklime into the centre. Then add water and cover with more sand. The quicklime heats and expands while the sand is scooped up to cover the cracks keeping the heat in the pile. A hot mix can also be made in a bucket, a belle or a pan mixer. Some of these will be demonstrated later
15. !
16. The result of making a hot mix with 3 sand and one quicklime might look like this. A very doughy and sticky mix. Very easy to use and particularly accessible to amateurs.
17. It can be used to make this
18. Or point this at Knockboy in Waterford - Tom Pollard
19. In combination with some hydraulic lime to point these chimneys in Kilkenny. Hybrid mix
20. Whatever form of lime mortar you may use it is vital to look after it. NHL may be able to set under water, but it's surface will be a mess if you try that, and if it was a wall, you will suffer from leaching. **Air lime made from quicklime needs to dry to start the carbonation process.** However the drying needs to take place throughout the thickness of the mortar otherwise it is liable to crack. Therefore in very dry conditions the rate of drying needs to be slowed and in wet conditions the water needs to be kept off. In addition the mortar is susceptible to frost, so in later autumn the coverings need to be insulated. If you use an air lime in the autumn it may not dry enough to start carbonation until the following spring, it will therefore need careful and continuous protection until that time
A good answer to this is to use a combination of hessian and DPM as in the bottom left photo. The top left photo shows a product from Traditional Lime near Tullow, which is a combination of insulation and waterproofing. On the bottom right picture the result of a lack of protection can be seen where the lime has leached down the stones.

21. The lime mortar needs to be between 30 and 80 percent moisture content in order to carbonate because the process involves a combination of both water and air. This provides the water in the pores and the carbon dioxide to acidify it. The acidity allows dissolution of the calcium hydroxide and then the presence of further carbon dioxide provides carbonate ions... The easiest way to achieve this is by dampening and drying as it will achieve the necessary moisture content during that process
22. Back to the lime cycle. The carbonation process is here, top left 11 o'clock
23. Finally protection.
Quicklime is designated as a hazardous material but not dangerous, and can be used on site providing appropriate health and safety procedures are followed. It is a highly caustic, reactive material which can cause irritation or burns if it is blown into eyes, inhaled or comes into contact with skin during slaking mixing or use. Wear appropriate PPE, including goggles, dust masks that are half face respirators not paper and gloves. Barrier cream may also be used. A sugar eyewash should be available at all times whenever mortars are being prepared, for instance: Diphoterine®. Note other materials such as cement are similarly hazardous and similar precautions should always be observed.