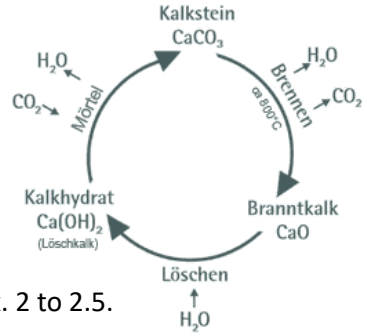
Lime Mortar

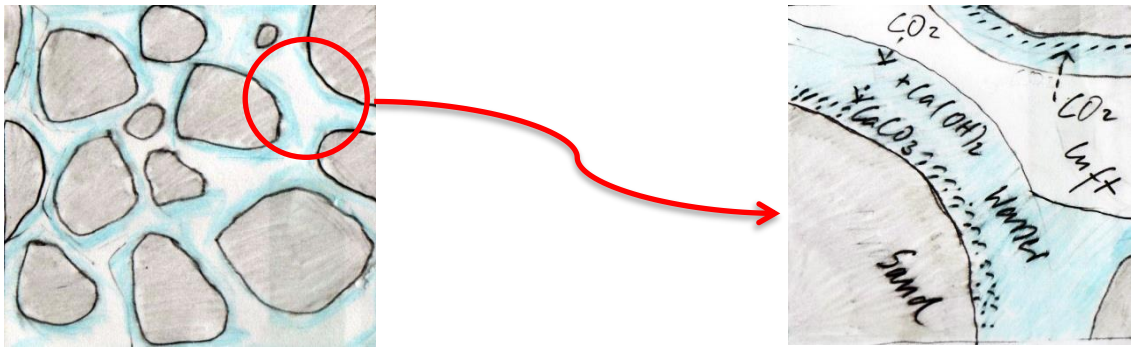
Ingredients: Pure lime (CaCO3) as binder and sand as aggregatef



Burning of the limestone: Limestone is burned at about 800°C. CO2 is split off from the lime and escapes as a gas. CaO remains. The limestone pieces look unchanged after burning, but are much lighter. The burnt lime CaO is stored as lump lime or ground as powder.

Slaking of the lime. If the slaked lime is slaked with water, calcium hydroxide Ca(OH)2 is formed. Heat is released and there is an increase in volume of approx. 2 to 2.5.

Setting / Carbonation. The setting of the lime takes place when the calcium hydroxide Ca(OH)2 combines with the CO2 from the air to form pure limestone CaCO3. For this reaction to proceed optimally, both CO2 must enter the mortar (via air) and sufficient moisture must be present for dissolved calcium hydroxide to be present. For the setting process, it is therefore important that the mortar does not dry out completely but is also not completely soaked. Regular moistening of the surface for about one month is ideal. The ambient temperature should not fall below 5°C.



Curing takes place from the surface towards the interior. This means that in the final state the mortar has a hard surface layer which becomes softer and softer towards the inside.

Hydraulic lime: In addition to lime, it also contains minerals that set hydraulically in the same way as cement. These minerals are of natural origin. So-called pozzolans (volcanic ashes, tuff, clay minerals, etc.) are also burned when the lime is burned. Hydraulic lime sets partly hydraulically, partly by carbonation.

Advantages of lime mortar

- Strength is not greater than natural stone.
- Longer workability than cement mortar.
- Vapor diffusion not limited.
- Stones can be easily separated from the mortar and can be reused
- Natural stone walls are built as structures without movement joints. Movements caused by temperature and moisture changes and shrinkage must be able to be absorbed in the masonry. If the mortar has a higher strength than the natural stone, the stone will break as a weaker component. Therefore, the mortar used should not achieve a higher strength than the natural stones, otherwise damage to the natural stones can be expected.

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- The mortar used should not hinder water evaporation from the masonry. Cement mortars are largely impermeable to diffusion. Water that has penetrated the masonry is prevented from evaporating by the cement mortar.
- The mortar used should allow for future renovations. Lime mortar develops less adhesion to natural stone than cement mortar. When demolishing a lime mortar wall, the stones can be separated from the mortar without problems.

Disadvantages of lime mortar

- Long and costly post-treatment (covering, keeping moist) to ensure carbonation.
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Production of lime mortar, variants

For production, lime (binder) and sand (aggregate) are mixed and applied as mortar. There are various methods of producing lime mortar:

Hot mixed lime mortar	**Dry slaked lime mortar**	**Lime putty mortar**
Slaking of the burnt lime (as lump lime or ground) directly in the sand when mixing the mortar.	Slaking of the burnt lump lime in the sand pile. Before mixing, sand and slaked lime are cut off and mixed. Water is added as needed.	Slaking and storing the burnt lime under water as quicklime. If required, sand is mixed with lime putty and applied as mortar.
Mortar during application warm/hot	Mortar during application cold	Mortar during application cold
Historical use as masonry mortar, base and leveling plaster. Arch masonry, grouting mortar.	Historical use as masonry mortar, base and leveling plaster	Historical use as finishing plaster, stucco
Properties: High binder content possible. Rapid stiffening, thus less waiting time when raising the masonry. Good adhesion. Low shrinkage cracking. Thick layers possible. Tends to have higher strength.	**Properties :** High binder content possible	**Properties:** Quicklime can be stored under water indefinitely without setting.
Recipe Lime to sand 1:3 to 1:5 (by volume). Due to the increase in volume of the lime during the slaking process, the mixture is approx. 1:3.	**Recipe** Lime to sand 1:3 to 1:5 (by volume). Due to the increase in volume of the lime during the slaking process, the mixture is approx. 1:3.	**Recipe** Lime to sand 1:4 to 1:6 (volume)
Use Masonry, grouting mortar, leveling plaster, plastering	**Use** Masonry, grouting mortar, leveling plaster, plastering	**Use** Fine plasters, stuccoes

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Rules of application for lime mortar

Preparation of the substrate

Removal of the old existing mortar. Clean the masonry with a vacuum cleaner, oil-free compressed air and water. No high-pressure cleaner should be used, as this device will wash away the remaining rel. soft lime mortar. It is better to use a garden hose. In order for the mortar to adhere optimally, the substrate must be clean, free of dust and loose particles. All growth of moss and lichen must be removed.

Pre-wetting

The surface must be sufficiently pre-wetted before applying the mortar so that the substrate does not draw too much moisture from the new mortar. This also allows the dissolved calcium hydroxide of the mortar to penetrate the pores of the substrate via the pore water. This increases the mortar-substrate bond**.**

Binder / Lime content

The binder should fill all voids in the aggregate (sand) without pushing the individual sand grains apart. The void ratio of a sand can be measured by adding water to dry sand until it starts to float. If there is an excess of binder, the risk of shrinkage cracking increases. If there is too little binder, the mortar will not achieve sufficient strength.

Mixing ratios (volume) of 1:3 (England) to 1:5 (Germany) are mentioned for hot-slaked caklmortar. 1:3 seems rather too "fat". A mixing ratio of 1:4 to 1:5 is realistic. It should be borne in mind that hot slaking increases the volume of lime by a factor of approx. 2 to 2.5.

Water content of the mixture:

Rule: As little water as possible, as much water as necessary. More water leads to greater shrinkage. Test: Apply the mortar to the wall of the bucket. If it adheres, the mixture is sufficiently pliable / moist.

Aggregate / Sand

The largest grain of the sand used should not be larger than the smallest joint width of the masonry. The sand should have a good grading curve, i.e. it should have a balanced grain size distribution.

Shrinkage / cracking

The thicker the mortar pack that is installed, the greater the tendency to cracking. It is recommended to integrate as many additional stones as possible in thick mortar sections (fitting whole stones that are stable without mortar. If this is not possible, the stones are fixed with stainless threaded rods / stainless nets). In general, it is better to apply the lime mortar in several thin layers. For the installation of thick mortar sections (when gouging joints), hot-slaked lime mortar is more suitable. Lime mortar prepared with lime putty is more susceptible to shrinkage cracking here. In the first few days, the surface of the applied lime mortar must be worked again. If the surface is scraped or brushed, the surface is compacted and small shrinkage cracks are closed. Also The skin of pure lime on the surface is removed and the sand grains are exposed so that the color of the sand becomes visible.

Control of climate

For the installation of lime mortars, the ambient temperature should be above 5°C.

Aftercare

All lime mortars must be kept moist after application, depending on weather conditions and location.

The solidification of the lime by carbonation takes several weeks and can only take place if there is sufficient moisture in the mortar. This means that a freshly installed lime mortar must be protected from drying out (wind, sun). Normally, freshly mortared surfaces are covered (e.g. with jute) and regularly moistened.

Frost / salt resistance

The frost / de-icing salt resistance of mortar depends, among other things, on the pore volume in the mortar. A larger pore volume increases the frost / de-icing salt resistance. Salt and ice crystals have more room to grow before they destroy the mortar's structure. One way to increase the pore volume is to add a porous aggregate: tufa sand**.**

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Sicherheitshinweise

Unslaked and slaked lime is strongly alkaline. When working with lime mortars, the following safety measures must therefore be observed
Eye protection: Wear safety goggles, have buffered eye rinsing solution ready.
Protection of the skin: Before working, apply skin protection ointment thoroughly to the hands.

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On Site mixtures

A distinction is made between mixing ratios in percent by weight or percent by volume. On the construction site, measuring in containers (volume) is easier than wheiging the ingredients.

Conversion values from weight to volume percent:

Hydr. Lime	(1 Bag à 50 kg = 55 ltr)	(1 Liter = ca. 0.78kg)
Cement	1 Bag à 50 kg = 43 ltr	
Tufa	1.25 kg = 1 Liter	
Sand:	1 Liter = ca. 1.2 - 1.5 kg	

Mixtures with lime putty

	Lime putty	Sand 0-8mm	Tufa-Sand 0-3mm
	By volume	By volume	By volume
Masonry mortar:	1	2	2
Grouting mortar	1	2	2
Also possible 1:3	1	2	1

Mischungen mit ungelöschtem gebrannten Stückkalk (trocken gelöschter Kalkmörtel)

- Wooden frame approx. 1 x 2m, open at the bottom against the soil.
- Mix 1 part burnt limestone to 6 (-8) parts sand (3 parts washed, 3 parts containing clay). After slaking, this corresponds to a sump mixture of 1:3 to 1:4.
- Put sand and lime in layers (usually 6 buckets of sand, 1 bucket of lime).
- Cover everything on top with sand, no exposed lime.
- Add very much water, rather than sprinkling, stick hose in pile sometimes. Add water. If water comes out the bottom by the frame it's ok.
- A barrel of lump lime has 200 kg. On a pallet fit 400 kg (price transport per pallet Fr. 150.-).
- One ton of lime costs Fr. 350.- to 450.-.
- One barrel of lime gives about 800l of mortar and you can realize about 10 m2 of masonry (0.6m) as internal masonry mortar.

Mixtures with unslaked burnt lump lime for immediate processing (hot lime)

Burnt lump lime sand (aggregate)

Volume parts

Masonry mortar: 1:4 (ev. 5) (3 is mentioned in English sources, seems too fat).

The lump lime is slaked and dissolves when water is added for mixing. The increase in volume of the lime during slaking increases the amount of binder in the finished mortar. Mixing must be continued until the lump lime has completely dissolved. There should be no unslaked lime pieces in the mortar.

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Mixtures with hydraulic lime

	Hydraulic lime	Sand 0-8mm	Tufa-Sand 0-3mm
	Volume parts	Volume parts	Volume parts
Masonry mortar:	1	2	1
Grouting mortar	1	1	1

Consumption / Calculation

Mortar consumption masonry: 295 l/ m3 finished wall. Mortar consumption pointing: 3 l/m2 finished wall
Mortar consumption masonry (guide values literature):
Very regular stones: 250 liters of mortar / m3 of finished masonry.
Less regular bricks: 280 liters mortar / m3 finished masonry.
Irregular stones: 300 -350 liters mortar / m3 finished masonry.

Mortar requirement pointing: 15 liters mortar /m2 finished surface

From these values, the need for lime and sand can be predicted, the values below give one m3 of finished mortar each:

NHL Sand mixture

Weight kg	Volume l	Weight kg	Volume l	Mixture
500	550	1400	1200	1:2
370	407	1500	1200	1:3
300	320	1625	1300	1:4

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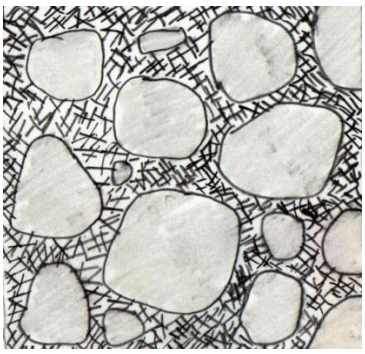
Cement mortar

Ingredients : lime and clay minerals.

Production: The minerals are finely ground and fired at high temperatures (approx. 1400 °C).

Hydraulic setting: Setting also takes place under water and in the absence of air. Crystals grow from the minerals dissolved in the mixing water, which form a dense felt around the aggregates as the setting progresses.



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