Further Explanations and Information on Lime Mortar Products

Information Source...LIME WORKS .US

Natural Hydraulic Lime

Natural Hydraulic Lime, although it is basically of the same chemical composition as Hydrated Lime, has its initial set with water, much like cement, and a second set by absorption of CO2. Being "hydraulic" allows for simplicity in many applications. Hydraulic Lime, like Hydrated Lime and cement requires some basic care such as minimizing the amount of mixing water, using good sand and tarping the work. The cost of labor when using NHL is therefore comparable to normal cementicious mortar and stucco installations which have been carried out correctly.

The hydraulicity, (which in true form is the ability to set with water and under water), for the St. Astier lime range is achieved only by the nature of the raw material. The St. Astier raw material is a naturally occurring hydraulic lime which is low-temperature fired. Nothing else is added to St. Astier NHL, therefore it is known as "Natural" Hydraulic Lime. It has known and measurable performance criteria which is both comforting and predictably dependable.

NHL 3.5

NHL 3.5 Moderately Hydraulic lime is used for applications such as laying or repointing brick, stone and terra cotta units even in extreme freeze-thaw climate cycles. It can be used to make scratch, brown and finish coats of exterior stucco or interior plaster. It has a significantly high "free lime" content that is responsible for self-healing mortars. The available free lime goes into solution during subsequent rains and then re-crystallizes across open fissures as is characteristic of historic pure lime mortars. NHL maintains a hexagonal plate crystal structure which allows the plates to go in between each other for greater flexural ability. Portland cement has a needle-like crystal structure which is brittle and must incorporate many control joints to strategically control cracking. NHL 3.5 is designated as a moderately hydraulic lime and will reach over 750 p.s.i. in six months when blended with 2-1/2 parts clean, sharp and well-graded sand. Most all above grade interior and exterior brickwork and stonework built with modern cement is recommended to be built using a Type N cement mortar, which reaches at least 750 p.s.i. in 28 days. Since modern designs call for structurally supporting steel or retaining walls made of concrete or concrete blocks laid with strong cement mortars, NHL mortars can be used for all of the veneer work, stucco and repointing where the old-world look, feel and properties of lime mortar is desired.

NHL 5

NHL 5 Eminently Hydraulic lime is used for applications such as building or repairing wall head copings, pointing and parging the water table or foundation of a building and making lime concrete. Sea-bearing walls can be built and repaired with NHL 5 since it has only trace amounts of soluble salts such as Potassium Oxide, Sodium Oxide and tri-calcium aluminates. This diminishes sulphate attack which normally happens in mortars prepared with Portland cement or where white cement has been introduced into synthetically created hydraulic lime at the time of manufacturing to ensure a hydraulic set. When Portland cement is present, you will find a high percentage of tri-calcium aluminates which will react with the sulphates thus producing an overall expansion and the eventual disintegration of the mortar or concrete especially in marine environments.

More of the Story on St. Astier Lime...

In 1833, Louis Vicat surveyed the limestone of the St. Astier basin in Dordogne, France, (near Bordeaux), where building limes have possibly been produced as early as the Roman occupation of the region. Vicat concluded that this material was suitable and appropriate for the production of Natural Hydraulic Lime. Industrial production began in 1851. Today, St. Astier Company's production capacity is over 100,000 tons per year. For over 150 years the St. Astier Company has supplied the required material that scientists, conservators, and practitioners have specified for repair, restoration, and new build work at some of Europe's most impressive historic buildings. Many of the buildings in Europe are much older than that in the United States and techniques in appropriate historic restoration have long been discovered and applied, such as the use of Natural Hydraulic Lime and sand to repoint over the bedding joints of buildings built with only lime and sand for mortar. Thousands of years of the history of lime and sand mortar have proven its effectiveness and the use has largely laid dormant in the United States for the last fifty years. Irreversible damage and the premature need for re-repointing of buildings has caused building owners and conservators in our country to seek alternatives to modern repointing mortars that are not working or don't have a long track record of success. The cost of mortar for repointing is inconsequential compared to the labor to do a job again if it is not done correctly. Many historic buildings over 100 years old in the United States, originally built with lime and sand mortar, are just now receiving their first repointing work. This helps to prove that the right lime and sand mixture can be very durable and cost effective to repeat the success of service that the historically proven mortar has given. St. Astier Natural Hydraulic Lime is truly a unique and rich exterior finish. Unlike the cold, urban look and feel of cement, natural hydraulic lime is a time-honored, old-world finish, enjoying a modern comeback due to its soft, rich, and velvety texture. Its ability to absorb multi-nuances of color is enhanced by the varied angles of sunlight reflected throughout a day. This is a finish that improves with age, always evolving, deepening, and taking on a character of its own. Its warmth lures one to touch and invites one to linger. Not only is St. Astier Natural Hydraulic Lime a pleasure to live with, but it is also healthy to live with. With no chemical additives whatsoever, St. Astier Natural Hydraulic Lime is the ultimate safe, natural, green building finish product-a throwback to the old world, rediscovered to help the environment of our new world.

Advice about locally available (Non-Hydraulic) Hydrated Lime

We don't sell Hydrated Lime because it is locally available in the US. However, lime comes basically in two forms, High Calcium which is pure and then two forms of impure lime which is designated either as Dolomitic or as Magnesian lime. Any of these limes could be processed into Hydrated Lime for building and sold as a "pre-slaked" dry powder - the most commonly used and known lime for building purposes.

Hydrated Lime comes in the powder form, designated as Type N, NA, S or SA, or in a paste form known as Lime Putty. Although it has wonderful physical and aesthetic qualities, Hydrated Lime has very strong limitations in the construction industry. It is used primarily with Portland cement to control the setting time and to add plasticity to mortar. Modern processing procedures for most all Hydrated Lime greatly restricts its use as a sole binder in Lime/sand mortars that will remain unprotected from the elements. An exception would be low-temperature fired High Calcium lime which, being around 98% pure calcium kept chemically intact by low-temperature firing, can be used to make a durable mortar without Portland cement. However this lime is mostly available for the food industry and will still require a six week protected cure time. Hydrated Lime sets only by carbonation in the re-absorption of CO2 and thus, thicknesses are very limited for mortars and plasters. Hydrated Lime alone with sand is not suitable or practical for standard thicknesses of scratch and brown coats in a plaster or stucco. High quality Hydrated Lime will work in most cases as an interior finish coat only requiring additional re-blending during the work.

The application of non-hydraulic lime for mortars and plasters requires very highly skilled labor and special care. This is especially true for quicklime to avoid physical harm from lime burns. Quicklime is the term used when obtaining a burned building lime prior to it being slaked with water or "hydrated." Consequently, these limes become a specialty product with associated complexities and costs.

Advice about synthetically created Hydraulic Lime

Hydraulicity can be given to Hydrated lime by only the addition of ordinary Portland cement or what is called a "pozzolan." The types of pozzolans vary with different performance outcomes for different pozzolans. A warning when introducing a foreign substance to create a pozzolanic hydraulic lime is therefore having immediate or long-range inauspicious consequences.

It is not advised to use hybrid products with unknown and unproven performance results. Hybrid products should be found in real service applications for an adequate time (years), in order to draw respectable conclusions. The Romans synthetically created Hydraulic Lime when the Natural Hydraulic Lime was not conveniently available to them. However, they never started with processed Dolomitic Type "S" (Double) Hydrated Lime that may be a dead-burned product incapable of standing on its own merits as a sole binder in unprotected external applications. The structures which are currently still in existence in the world, which were built by the Romans, also utilized pozzolans which have stabilized since they have proven what can be expected in a final performance outcome if the pozzolans were used in a similar application starting with a similarly obtained and produced lime. Except for the known outcome of using Portland cement as the pozzolanic agent with Type S Hydrated Limes in modern new building work, it is not advised to use synthetically created hybrid hydraulic lime with no track record for any building of value. This is especially true when the subject is the repair of historic heritage buildings. Any sustainable new structure which is being built with the intent of creating a sustainably durable and long-term service life component should avoid the experimental use of a synthetically created hybrid hydraulic lime.

If one were to add a pozzolan to Hydrated Lime then Portland cement would be favored as a material of choice to make a synthetically created hydraulic lime. This is because Portland cement and Type S Hydrated Lime have a known and understood outcome for making successful modern mortars and stuccos which have been in use over 50 years for many modern applications. When value engineering a synthetically created Hydraulic Lime, Portland cement and Type S Hydrated Lime is a favored approach solely because of the low expense coupled with the familiarity of its use by masons and the known service life found in certain applications.

This is not, however, the case for the repair of vintage buildings and for pursuing lower embodied energy mortars. For the purpose of building sustainably and therefore building "Green" it is advisable to take a scientific approach when designing a mortar. In the final analysis any Hydraulic Lime ordered and utilized on a project should be sure to be the type required to meet all the requirements of the application first and foremost. One must secure in advance all proven, long-term success evidence before carrying out the application. If this due diligence is not adhered to there could be disastrous results for the project built with a hybrid hydraulic lime. Knowing that the St. Astier Natural Hydraulic Lime range has a proven track record that can be relied upon is also a good deterrent to the trial and error approach for mortar being used to build valuable structures.

Undue expense for obtaining a hybrid lime mortar for building is not warranted if the application fails pre-maturely or causes surrounding failure for other building components resulting only in excessive overall building expense without benefit. The initial benefit of using a synthetically created hydraulic lime may be focused on initial energy savings in raw material production. However, the long-term energy loss due to the cost to replace failed materials if a hybrid hydraulic lime fails to work as

intended becomes for the owner, the architect and the installers just an expensive and troublesome exercise in futility.

Grout Injection Mortars

MIX 1	MIX 2	MIX 3	NOTES	
Dosage	100% Coulinex + water	50% Coulinex/50% sand 400µ-200µ + water	75% Coulinex/25% sand 400µ-200µ + water	
SO4 content %	0	0	0	Should not be above 0.5%
Organic content %	0	0.2	0.2	Should not be above 1%
Bulk density g x liter	579	996.5	894	Powder only
Water addition - grams	875	375	600	Per kg. of powder
Fluidity Marsh cone 10mm	24	13	16	Should be between 13 and 25 seconds
Stability* % @ 3h	1.05	0.25	0.2	Should be <3% @ 3 hours
Stability* % @ 24 hours	1	0	0	Should be NIL at 24 hours
Comp. Strength N/mm2	1.35	1.43	3.17	28 days cured 7 days in the mould and dried before testing
Tens. Strength N/mm2	0.31	0.55	1.07	ditto
Bulk density g x liter	1383	1768	1605	ditto
Comp. Strength N/mm2	4.87	4.48	5.18	90 days
Tens. Strength N/mm2	1.32	2.27	2.91	ditto

Bulk density g x liter	1381	1828	1632	ditto
Comp. Strength N/mm2	5.18	5.20	6.0	180 days
Tens. Strength N/mm2	1.41	1.42	1.63	ditto
g x liter	1378			ditto

Over 3% of the grouting/injection mortar will become unstable and leaching can occur.

Ecological Injection Grouts

Main Data and Application Recommendations

COULINEX, based on NHL 3.5, is a grout, which can be used for injection. It has no cement or pozzolanic additions and can be used on its own or with the addition of sand, depending on the size of the voids. COULINEX can be applied by gravity feed or by pump with a very low pressure. In fine injection work it can be applied on its own or with very fine aggregate, depending on the voids size.

When grouting porous materials, clean water should be used first to reduce suction to avoid the risk of blocking some voids, impeding the grout to fill the whole of the grouting area. This operation should be conducted slowly and with care, making sure that there is no free water (saturation) in the cavity. This can be done by making a small hole in a joint at the bottom of the grouting area, if water pours out one should stop adding water and wait for the water to be absorbed by the structure.

COULINEX can be applied by gravity feed or by pump with a very low pressure. In fine injection work it can be applied with or without very fine aggregate, depending on the size of the voids.

Injection and grouting work normally starts from the lowest part of a structure or the section of a structure to be treated. Re-pointing work is done before the intervention, to the level of the first grouting/injection point. About 24 hours later, the operation is repeated on the section above, until completion of the work.

Grouting can also be used in retrofilling work when stones or bricks have been changed in a section of a structure. Here the size of the voids is known and therefore the joints work can be done on larger areas. To allow COULINEX to achieve its best performance, however, the grouting work should be performed in stages at 24 hours interval, depending on the porosity of the materials with which the grout will be in contact.

In choosing a grout, particular attention should be paid to its "stability". This is the property of the grout to retain unnecessary water (this is the water exceeding the amount required for hydration and fluidity) not allowing it to flow freely. It is measured in hours and, ideally, a zero should be achieved within 24 hours although figures of about 1% are still considered low enough for further work to continue. In other words, within 24 hours either zero or only a small percentage of water is free to flow. Tests conducted on COULINEX show that this value is achieved within the time stated.

Injection and grouting materials should not contain sulphates and organic components, especially in restoration/conservation work. None of these is contained in COULINEX. Dense and non-breathable mixes (cementitious) can cause severe long term damage, especially if dense mortars are applied also in the joints, as eventual moisture will not be able to evaporate and condensation will be created. In the

presence of porous stones or bricks, the moisture will be absorbed by the bricks or the stones. Moisture movement will also generate the migration of salts that might be present within the structure and unnecessary pressure will be generated within the structure itself.

Packing:
Coulinex L 55 lbs. (25 kg bags)
Coulinex M 44 lbs. (20 kg bags)

Shelf life:
8-12 months kept sealed and dry
Can be applied via low pressure pump

Working Temperatures:
Not below 40 degrees F or above 85 degrees F
The area must be dampened to control suction.

Mix ratio	Coulinex L only + water	1:1 (Coulinex M) sand No. 40 - No. 70 + water	3:1 (Coulinex L) (sand No. 40 - No. 70 + water) - on site mix
Compressive strength - psi (N/mm2)			
28 days	195(1.35)	207(1.43)	460(3.17)
90 days	706(4.87)	650(4.48)	751(5.18)
6 months	751(5.18)	754(5.2)	870(6.0)
Tensile strength - psi (N/mm2)			
28 days	45(0.31)	78(0.55)	155(1.07)
90 days	191(1.32)	329(2.27)	422(2.91)
6 months	205(1.41)	206(1.42)	236(1.63)
Water	±5.5-6 gal/25 kg bag	±2 gal/20 kg bag	±3.2 gal/ 20 kg powder
Setting time	21 hours	15 hours	
Bulk density lbs/ft3(g/liter)	36.1(579)	62.2(996.5)	55.8(894)
SO4 content %	0	0	0
Organic content %	0	0.2	0.2
Consumption	25 kg of material + water = 1 cubic feet	20 kg of material + sand + water = 0.5 cubic feet	
Fluidity Marsh Cone 10mm	24	13	16

(Should be between 13-25 seconds)			
Stability % @ 3 hours	1.05	0.25	0.2
Stability % @ 24 hours	1	0	0

Ecologic™ Mortar

Ecologic™ Mortar, in any of the stock colors, are simply a prepared blend of binder/aggregate/pigments to which you just add water, mix and go to work. Use it to repoint historic buildings, stucco and build new buildings which are considered a Green Application and result in a desired "Old World" Lime finish. It is as simple as mixing the mortar with water using a high torque industrial electric drill and a rigid paddle attachment in five-gallon pail or using a mason's paddle-style mortar mixer. The bag weight is 38.5 pounds. Ecologic™ Mortar is coded as "DGM" followed by a number to correspond to a certain stock mortar color. "SCG" on bags means "Standard Construction Grade" where no pigment is added. Type "F" stands for "fine sands" for the application of butter joint repointing, fine jointed Ashlar stonework and for smooth stuccos. Type "G" stands for "coarse granules" for most all other applications. The granules in Type G are coarse in comparison to the fine sands in a Type F mortar, but the coarse granules are likened to regular mason's sand that meets ASTM C-144 standards for sharp, well-graded sand. The coarse grains are not as coarse as typical concrete sand. Type F and Type G sands have a range of grades making up the majority of the component sizes in the entire sand blend. All Stock Ecologic™ Mortars are made with NHL 3.5 and “G” type sand blend. Ecologic™ Mortar (F) with fine sand is also made with NHL 3.5 and is a stock product in the SCG Non-Pigmented color only. All other mixes are considered a custom blend.