

St Astier Limes

Grouting principles, materials and performance

Grouting is a means to fill voids and consolidate structures with minimum intervention. In some ways grouting could be viewed as being one of the primary tools in minimizing intervention in historic building fabric. However grouting once placed is extremely difficult if not impossible to remove so the core principle of reversibility is to a large extent negated.

Based on this approach it is therefore essential to understand the performance and composition of any grout, but to do so also involve an understanding of the rationale for grouting in the first place.

Historic masonry structures can take many forms and range from relatively thin walls for domestic dwellings to substantial massive engineering or fortifications. Typically walling for domestic dwellings fall in the range 375 mm (15") to 750 mm (30") or there about and can be brick or stone and generally constructed with lime mortar, although not exclusively as clay was a commonly used mass wall building mortar.

Voiding is principally as a result of wash out of the core mortar, often simply as a function of failed building details or indeed the absence of robust detailing, or loss of roofs and the like allowing uncontrolled water ingress into wall heads and below. In other instances it can be as a result of movement or a combination of movement and wash out through open joints.

In all instances where voiding occurs it creates water pathways. Water pathways are not in themselves necessarily problematic in the long term, this depends on the building or structure and its location, environment and other factors such as whether the primary function of the masonry is to exclude water and maintain a dry envelope.

What is certain is that water pathways can provide routes from one part or location in a mass wall to another possibly as yet unaffected area resulting in accelerated wash out.

Vaulted structures are particularly susceptible to deterioration through voids caused by water pathways, bridge arches being a prime example.

Types of Voids and Pathways that are commonly encountered in mass masonry walls include:

- cracks or open joints in vertical faces that may lead to isolated or connected voids.
- cracks or open joints in wall heads that provide easy location for plant growth and the rapid formation of connected voids.
- voids caused by collapsed flues and bridges that have both connected voids and water pathways that may act as drains in some circumstances.
- Isolated voids that are not connected and often caused by previous interventions such as indenting of stone or brick or insertion of lintels and the like.

Voids and pathways which have also become sites for plant development can result in rapid deterioration in the integrity of masonry, as root systems exploit tiny spaces between materials, grow and develop girth and length and cause disruption as they thicken.

Leaking gutters and rainwater goods can have a dramatic impact on the rate of binder depletion in localised situations that can also have associated mosses and lichen growth that also works deeply into cavities, retaining moisture in dry atmospheric conditions and encouraging further additional plant species to take hold.

In river courses or between low and high tide levels or within canal systems, wash out and differential pressures exerted by water movement can create complex and significant voiding that left unchecked can lead to water penetration and significant masonry loss in a relatively short time frame.

Grouting can therefore significantly improve the life span of a building or structure that has suffered voiding and the creation of water pathways, provided the grout is

- A Compatible with the host masonry
- B Does not introduce components that could impact negatively upon the structure
- C Is of an adequate strength and of similar materials to the core mortar.

Grouting can irrevocably damage the building or structure where materials are

1. Stronger than the original, leading to differential stresses being set up.
2. Where materials contain alumina, sulphates and other salts which may in conjunction with water, result in damaging expansive reactions taking place, often over a number of years.

The existence of voiding is commonly visible to the eye. Leaching of binder, settlement, bulging and plant growth in walls are very good indicators.

Determination of voiding can be carried out by minimal invasive examination with opening up of mortar joints, investigation of voiding depths by use of wire or flat tapes, rules, and other suitable tools.

In some circumstances, such as massive bastion walls capped with clay and grass wall heads and on harbour walls and the like, coring from the top of the wall with a diamond core drill will give a vertical section through the structure at the least visible point that can be easily reinstated. The cores can be highly informative, depending on initial core examination, more or less coring can be instructed.

Often voiding is exposed during repair programmes, or is obvious when vegetation is visible or where bulging has occurred. It is not possible for a masonry wall to change its shape through bulging without voiding occurring, the mere fact that movement has occurred and the wall is wider at the point of bulging than it was at its original build by definition means that something has had to give somewhere.

Non-destructive non invasive investigation methods include thermo graphic imagery, which sometimes requires confirmatory invasive investigation. Only very experienced Thermographers are usually able to analyse data sufficiently well to adequately interpret void structures and the work is to a large degree weather dependant. Alternatively, conditions can be manipulated to allow the thermography to provide the data necessary for proper interpretation. It is almost always necessary to confirm the data by invasive examination, but the Thermo graphic analysis can focus the investigation to a much narrower area and as such is less invasive than most other methods.

Radar examination can be used, although there are very few exponents of this technique who have sufficient skill or indeed sufficiently sophisticated software to analyse the reflectance data. However it is, when carried out properly, a remarkable technique capable of showing very fine fracturing in masonry units and voiding in between individual stones where mortar has been eroded or depleted.

Once the decision is taken to grout, the main issues that require to be addressed are:

Consolidation of structures demands that products used in injection and grouting interventions are chemically and mechanically compatible with the structure of which they are to become part of. (See points A-C and 1-2)

In addition to the requirements for materials to be compatible and fit for purpose, the grouts have to be capable of filling the voids properly, have very low shrinkage and re-absorb as high a proportion of their mix water as possible to avoid creating new or additional voids, particularly if they form capillary voids that can lead to significantly wetter walls in the long term.

- St Astier Natural Hydraulic Lime Grouts NHL 3.5 and NHL 5 are free of Portland Cement, PFA, GGBS or other additions with the exception of minute quantities of Bentonite clay and super-plasticisers, essential in reducing water demand whilst improving the fluidity that ensures the grouts flow properly into voids, linked or otherwise.
- The absence of high levels of Alumina and sulphates in the binders and relatively low levels of free lime or Calcium Hydroxide ensures that there is no potential from the grouts to create sulphate attack or diminish the binding qualities of the grout through lack of carbonation and encouraging lime leaching.
- Water, the principle engine of decay for masonry, and one of the principle causes of voiding can strip free lime rapidly from binders resulting in migration to the face of walls. Deep in a wall, excluded from air, free lime will not carbonate. Calcium Hydroxide goes into solution at a ratio of 1:6 with water; this is seen as lime leaching.

Special Grouts for below the water level or faster setting grouts are also possible, in these instances, the use of Natural Cement to provide faster setting allows St Astier Natural Hydraulic Lime Grouts to be placed under water with negligible binder bleed in sea water or river courses without risk to wild life or fish stocks.

To ensure that all St Astier Grouts are fit for purpose, they have been subjected to testing in environments that more closely match real life conditions (i.e humid ambient conditions and in variable void sizes).

Tests are conducted on standard mortar prisms:

- A. Cured at 90% RH throughout the testing period
- B. Mixes were devised at various levels of product content (with and without aggregate) and water addition to check their mechanical performance

The main parameters are:

1. Measure fluidity of various mixes (Marsh cone 10mm diameter). Fluidity values between 13 and 25 seconds for free flowing grouts, 26-45 seconds for pressure pumped mixes.
2. Measure the stability of the product. Stability is the property of the mortar to reabsorb the water "decanted" during its settlement in the void (*bleeding*). This ensures that the evaporation of the water decanted does not create another void. The tolerance values we look for are: max. 3% at 1 hour and aim for potentially "0" at 24 hours. *This varies slightly from one grout to another as other criteria may be more desirable*
3. Measure compressive and tensile strength at various ages 72 hours – to 90 days

Performance in use:

Grout fluidity and retention of mix water are the two critical components that require careful adjustment of the additions in a grout.

Flow rates, measured in seconds with a Marsh cone, sets a bench mark flow comparison with water.

The gel component is important where liquid water is present.

The use or placing of the grout determines the characteristics the grout must have to ensure that voids are properly filled. The method of placing is also relevant.