

NOTES ON SPECIFICATION FOR LIME FOR USE IN SOIL STABILISATION

(These notes are for guidance of the supervising officers and consultants commissioned to draft tender documents and must not be included in contract documents)

1. SCOPE

This specification has been developed to give assurance that the lime at the date of delivery meets the quality standards presented in the body of the specification. The specification covers the requirements for sampling, sample preparation, testing and quality control for the supply of lime.

2. TERMINOLOGY

The definitions for quicklime and for hydrated lime and their grades are described in the specification but merit an example:

Where the design requirement is 8kg/m² of CaO, but it is wished to spread the lime in the hydrated lime form, then the required spread rate of pure hydrated lime would be:

- $$\begin{aligned} \text{Ca (OH)}_2 &= 8 \times 132/100 \\ &= 10.56\text{kg/m}^2 \end{aligned}$$

If the grade of the hydrated lime is 92% then the spread rate of the hydrated lime would be:

- $$\begin{aligned} \text{Hydrated lime} &= 10.56 \times 100/92 \\ &= 11.5\text{kg/m}^2 \end{aligned}$$

For this example the target spread rate for the hydrated lime would be 11.5kg/m².

A further example is contained in clause 6 of these notes.

3. GRADE OF QUICKLIME AND HYDRATED LIME

OPTION OF QUICKLIME OF GRADE < 85

If the Engineer wishes to use quicklime with a lower grade than the minimum 85% of the M/15 specification, then all of the following shall apply:

- The quicklime is to have an Available Lime Index when tested to ASTM C25:2006 of $\geq 75\%$, and
- A representative sample is to be tested by full X-Ray Diffraction (XRD) and the test results shall be made available to the Engineer, and
- Sampling and testing for the XRD tests is to be performed by a laboratory accredited to ISO 17025 (eg International Accreditation New Zealand, IANZ, accreditation).

- The samples must not contain any coal dust, hydrocarbons or other undesirable or deleterious materials, and
- The Engineer must give written approval for that lime before delivery and before its use as a stabilising agent.

The lower the grade of the lime the greater the chances are for undesirable impurities. Undesirable impurities could include clays, coal dust, silica or under-burnt limestone. The consequences of these impurities in the pavement will depend partly on which pavement layer(s) the lime is used in, with impurities in a stabilised basecourse likely to be of more concern than impurities in a stabilised subgrade.

Under-burnt limestone can slowly rupture within the pavement, which could lead to premature pavement distress. If the Loss on Ignition test result is $\geq 1.5\%$ this could indicate under-burnt limestone. The results from the X-Ray Diffraction tests should include Loss on Ignition results.

Note that should the approved lime be of a grade less than 85, then additional lime will need to be used in the stabilising process to provide the desired rate of addition of CaO or Ca(OH)₂.

3.1 Certified Grade

There are two possible procedures for certification of both quicklime and hydrated lime dependent on the method of sampling.

The method that is expected to be used to the greatest extent is a statistical assessment of the variability of a given Producer's lime. To be meaningful this requires a stable process that is in a state of statistical control. This method requires regular sampling from the production process and involves assessing the lime's grade in such a manner that the certified grade is expected to be exceeded by 90% of the certified product.

There are rules for deciding when a process is out of statistical control. It can be concluded that the process is out of control if any of the following events occur.

1. A point falls above the upper control limit (mean + 3 standard deviations) limit or below the lower control limit (mean - 3 standard deviations).
2. Two out of three consecutive points fall above the mean + 2 standard deviations limit or two out of three consecutive points fall below the mean - 2 standard deviations limit.
3. Four out of five consecutive points fall above the mean + 1 standard deviation limit or four out of five consecutive points fall below the mean - 1 standard deviation limit.
4. Eight or more consecutive points lie above the mean or eight or more consecutive points lie below the mean.
5. Eight or more consecutive points move upward or eight or more consecutive points move downward.

The second method requires sampling and evaluating the available lime index for each individual truck load. In this case the measured available lime index is the certified grade.

A Producer will be continuously observing the accumulation of regular control data and will doubtless develop warning and action limits appropriate to their particular operation.

3.2 Job Lot Grade

In appendix 2 of these notes reference is made to some of the factors which may affect a job lot available lime index test result. The cause of any difference between the grade certified by the Producer and that assessed from job lot testing cannot easily be assigned.

However, where job lot testing has been demanded and has resulted in regrading of the product, this can be accommodated within the basis of payment in clause 8 of the specification. In this case the job lot grade would be the characteristic used in determining the quantity of active ingredient, in accordance with the example in clause 8 of these notes.

Similarly, a job lot grade result can be used to adjust the spread rate in order to achieve the designer's objective.

4. PARTICLE SIZE DISTRIBUTION

The quicklime particle size distribution included in table 1 of the specification has been found in practice to be the most suitable grading for effective uniform slaking.

Within the limits for quicklime in table 1 the Engineer or the Contractor may ask for a specific size range, eg lump lime, granules, or fines

5. RESPONSIBILITY FOR SAMPLING, SAMPLE PREPARATION AND TESTING

5.1 Responsibility for Regular Control Sampling, Sample Preparation and Testing

Regular control testing by the Producer is the main form of quality control, with job lot testing only required where uncertainty as to the characteristics of the certified lime and a potential technical or economic benefit from initiation of job lot testing exists.

Particle size distribution control testing is left to the Producer's discretion with the suggestion that a procedure should be implemented to provide adequate confidence in the compliance of the certified product and the requirements of table 1 of the specification.

5.2 Responsibility for Job Lot Sampling, Sample Preparation and Testing

The initiation of a requirement for testing of a job lot is a significant matter and this decision should not be taken lightly. The cost of job lot testing can be substantial, so the recovery of charges incurred has been specifically detailed.

Testing of a job lot will enable a supervisor to be satisfied that the characteristics certified as appropriate to the product in question are in fact reasonable. The flexibility in the size of a job lot should enable both isolated defects (truckloads) and gross problems to be adequately assessed (see also appendix 2 of these notes on job lot size). It is important to emphasise that the certification by the Producer in accordance with the specified regular control testing procedure is seen as being the primary mechanism within the quality assurance scheme.

6. PACKAGING AND CARTAGE

Safety

Hydrated lime is not dangerous to work with providing a few simple precautions are exercised.

Quicklime is considerably more dangerous than hydrated lime. Quicklime can produce severe burns quickly when in contact with moist skin. A fleck of quicklime in the eye can severely burn the eye.

The Job Supervisor should ensure that people handling or exposed to hydrated lime or quicklime wear dustproof goggles and protective clothing at all times. This also applies to people handling sealed bagged lime, although it is essentially safe to handle.

Any area of skin that has come in contact with the lime should be rinsed thoroughly with water as soon as possible. If eyes come into contact with lime they should be flushed out with water immediately.

The Producers are able to supply a list of the best protective equipment available together with a comprehensive Materials Safety Data Sheet. It is strongly recommended that these data sheets be obtained and kept readily available on the site of any lime stabilisation operation.

6.1 Quicklime or Hydrated Lime

In the case of a supply and construct contract the designer will base the requirement for lime on the quantity of calcium oxide or calcium hydroxide respectively needed to achieve the desired stabilising effect. The grade of the quicklime or hydrated lime is merely the tool used to assess the mass of product required to achieve the designer's objective. The application of this concept means, for example:

Where design requirement is 2kg/m² of CaO

and grade of quicklime supplied = 90

the spread rate of quicklime = 2 x 100/90
= 2.2kg/m²

APPENDIX 1 (NOTES)

SAMPLING, SAMPLE PREPARATION AND TESTING FOR REGULAR CONTROL

1. SCOPE

SAMPLING FOR REGULAR CONTROL OF THE GRADE

The prime form of quality assurance is collection and testing of samples by the Producer, from the daily production.

The purpose of referring to ASTM C50-00 (2006) is to provide a recognised source where a description of the methods of sampling quicklime and hydrated lime appears.

Currently quicklime and hydrated lime are used in a number of industries other than roading. The amount used in road is only around 20% of the total production of quicklime and hydrated lime in New Zealand. Some of the other industries demand higher standards of purity for quicklime or hydrated lime than are needed for road stabilisation.

This gives some confidence that the quicklime or hydrated lime, as currently produced in New Zealand, is of grade ≥ 85 .

However, checks and controls are still needed to ensure that only good quality quicklime and hydrated lime is supplied for road stabilisation.

For the Producer certified grade the sampling location is left to the discretion of the Producer. The onus is on the Producer to select a location which ensures that the results reflect the characteristics of the lime supplied. This is considered reasonable in view of the potential for job lot testing and the demand for high quality lime by other industries in New Zealand.

2. SAMPLING FOR REGULAR CONTROL OF THE GRADE

SAMPLE PREPARATION FOR TESTING THE GRADE OF REGULAR CONTROL SAMPLES

It should be noted that grinding of hydrated lime to pass a 150 μ m test sieve may not be required due to the fine nature of hydrated lime. The purpose of grinding is to provide a sample which can readily be divided into 2.804g samples as required for testing in clause 28 of ASTM C25-06.

APPENDIX 2 (NOTES)

SAMPLING, SAMPLE PREPARATION AND TESTING OF A JOB LOT

2. SAMPLING OF A JOB LOT

Notwithstanding that the definition of job lot size rests with the initiator of the demand for job lot testing, it is recommended that the size of the job lot should be mutually agreed upon by the parties to the contract prior to sampling. See also clause 5.2 of the main body of these notes.

Although sampling of a job lot of quicklime is permitted subsequent to its despatch from the Producer, it is important to recognise that the effects of carbonation and hydration of the quicklime can reduce the available lime index test result. This occurs because a fixed mass of calcium ions will become a lesser proportion by mass of the weighed test sample once it partially recarbonates or hydrates. The result of this is that the handling and storage of quicklime has an effect on the available lime index which cannot be readily distinguished from its production characteristics.

Hydrated lime does not have a hydration problem although it may carbonate. Although sampling of a job lot of hydrated lime is permitted subsequent to its despatch from the Producer, it is important to recognise that the effect of carbonation can reduce the available lime index result. The result of this is that the handling and storage of hydrated lime has an effect on the available lime index which cannot be readily distinguished from its production characteristics.

Although New Zealand investigations to date indicate that the available lime index result of properly sampled job lots is not sensitive to good handling practice, it is necessary to carefully document the time and place of job lot sampling so that there is no question as to what a particular sample represents. The interpretation and use of job lot results is discussed in clause 3.2 of these notes.

3. SAMPLE PREPARATION OF JOB LOT SAMPLES FOR TESTING

It should be noted that grinding of hydrated lime to pass a 150 μ m test sieve may not be required due to the fine nature of hydrated lime. The purpose of grinding is to provide a sample which can readily be divided into 2.804g samples as required for testing to clause 28 of ASTM C25-06.