

# **SPECIFICATION FOR LIME FOR USE IN SOIL STABILISATION**

## **1. SCOPE**

This specification applies to the supply of calcium oxide or calcium hydroxide for use in soil stabilisation.

Calcium oxide and calcium hydroxide are the active ingredients within the materials supplied under the names of quicklime and hydrated lime respectively.

The primary form of quality assurance for lime supplied in accordance with this specification involves standardised Producer certification of the grade of the lime, based on testing to Section 28 of ASTM C25 - 06.

## **2. TERMINOLOGY**

Quicklime (also known as burnt lime) is normally a granulated material which has calcium oxide (CaO) as the active ingredient. It can be supplied as fines, granules or lump material.

Hydrated Lime (also known as slaked lime) is a powdered material which has calcium hydroxide (Ca(OH)<sub>2</sub>) as the active ingredient.

Producer is the manufacturer of the quicklime or hydrated lime to which this specification applies.

Contractor is the construction agency carrying out the lime stabilisation where this specification forms part or all of the contract.

Job Lot is a unit of quicklime or hydrated lime which is part or all of the product to which this specification applies.

Particle Size Distribution of quicklime or hydrated lime is determined by dry sieving in accordance with this specification.

Available Lime Index designates the percentage of those active ingredients that enter into the reaction under the conditions of the test of Section 28 of ASTM C25-06, *“Standard Test Methods for Chemical Analysis of Limestone, Quicklime and Hydrated Lime”*.

Grade of Quicklime or Hydrated Lime is the available lime index determined in accordance with Section 5 of this specification, or determined from job lot testing.

Lime is an abbreviated term to refer to quicklime and/or hydrated lime.

## **3. GRADE OF QUICKLIME AND HYDRATED LIME**

The minimum grade for acceptance of quicklime or hydrated lime to which this specification applies shall be 85%.

### 3.1 Certified Grade

Where the Producers production can be said to be in a state of statistical control the Producer shall certify the grade. The certified grade shall be either:

- (a) Equal to the Mean Available Lime Index minus the product of 1.25 and the Standard Deviation Available Lime Index.

where: Mean Applicable Lime Index is the mean of the 30 most recent consecutive control test results including at least one result obtained from a sample taken not more than three working days prior to the production of the material certified.

Standard Deviation Available Lime Index is the standard deviation of the 30 results used in calculating the Mean Available Lime Index.

or

- (b) The Actual Available Lime Index obtained from each and every truckload of lime supplied by the Producer.

Records detailing the basis of the certification of the grade in accordance with this specification shall be made available for examination by the Engineer at the Producer’s lime works on request.

### 3.2 Job Lot Grade

Sampling and testing for job lot testing of the lime may be initiated by the Producer, the Engineer or the Contractor.

In these cases, notwithstanding the assessment and certification defined in Clause 3.1 above, sampling, sample preparation and testing in accordance with Appendix 2 of this specification for the available lime index shall be undertaken for a particular job lot. In this case all of the job lot will be assessed and paid for on the basis of the available lime index for that job lot, ie the Job Lot Available Lime Index.

$$\text{Job Lot Grade} = \text{Job Lot Available Lime Index}$$

## 4. PARTICLE SIZE DISTRIBUTION

All quicklime or hydrated lime supplied in accordance with this specification shall be accompanied by the Producer’s certification that the product complies with the appropriate particle size distribution of Table 1 below.

A regular control testing procedure for particle size distribution determination is not defined herein. Producers shall establish control procedures which take account of particle size distribution variability so as to provide suitable confidence of the acceptance within the provisions for job lot evaluation.

BS Test Sieve Size	Percentage Passing for Quicklime	Percentage Passing for Hydrated Lime
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26.5mm	100	100
0.300mm	-	100

**Table 1: Particle Size Distribution for Quicklime and for Hydrated Lime**

Notwithstanding the Producer's certification, the Engineer and/or the Contractor may require sampling and testing of the particle size distribution of lime of a particular job lot, all of which shall be rejected should the job lot test result, determined in accordance with Appendix 3 of this specification, prove defective.

All sampling for the testing of a job lot for particle size distribution shall be undertaken before the lime leaves the Producer's site, or if the Producer is transporting the lime before discharge from the transporter.

Within the limits of Table 1 above, the Engineer and/or the Contractor may request a specific particle size distribution. This will be subject to agreement with the Producer.

## **5. RESPONSIBILITY FOR SAMPLING, SAMPLE PREPARATION AND TESTING**

### **5.1 Responsibility for Sampling, Sample Preparation and Testing for Regular Control**

Regular sampling, sample preparation and testing shall be undertaken by the Producer to certify the grade of the lime in terms of Section 3.1 above and certify the particle size distribution in terms of Section 4 above.

All costs incurred for this regular control sampling, sample preparation, testing and certification shall be met by the Producer.

### **5.2 Responsibility for Job Lot Sampling, Sample Preparation and Testing**

In general, job lot testing will only be initiated when there is a perceived need to reassess the appropriateness of the characteristics certified. The requirement for testing of a job lot may be initiated by the Producer, Contractor or the Engineer.

The sampling, sample preparation and testing procedure shall be as specified in Appendix 2 of this specification. The sampling and sample preparation shall be carried out by an agent nominated by the initiator of the demand for job lot testing. Actual testing shall be carried out by the respective Producer and/or Contractor and/or Engineer and/or Arbitrator as necessary in accordance with the procedures defined in Appendix 2.

Payment for sampling, sample preparation and testing of a job lot shall depend on the actual test results (see clause 8.2).

## **6. PACKAGING AND CARTAGE**

Quicklime is available in 25kg bags, 1 tonne bags, bulk truck, bulk truck and trailer, and bulk pneumatic tanker.

Hydrated lime is available in 25kg bags, 1 tonne bags, and bulk pneumatic tanker.

For transporting by truck, or truck and trailer, the lime must be fully covered to prevent exposure to dampness, and to prevent adjacent persons or property from coming into contact with the lime.

For transport in a pneumatic tanker, the tanker must have current certification with the certification number clearly visible.

## **7. STOCKPILING AND STORAGE LIMITATIONS**

The duration of stockpiling or storage of lime either in bags or in bulk shall be kept to a minimum. In no circumstances shall it be stored for more than three months from the date of supply.

During any storage or stockpiling the lime shall be covered, and shall be protected from exposure to moisture at all times. Any lime that does not comply with this specification due to exposure to the air or to moisture before use shall not be accepted.

Any lime in storage or in stockpile must be in a secure area that is not accessible by the general public.

## **8. BASIS OF MEASUREMENT AND PAYMENT**

### **8.1 Quicklime or Hydrated Lime**

When the contract is for the supply only of either quicklime or hydrated lime, the item unit rate will be in terms of tonnes of quicklime or tonnes of hydrated lime conforming to the requirements of this specification and delivered to the site.

In the case of contracts of which all or part involves soil stabilisation with either quicklime or hydrated lime, the item unit rate will be in terms of tonnes of quicklime or tonnes of hydrated lime conforming to the requirements of this specification and incorporated in the completed job. No payment will be made for any quantity in excess of that directed and approved by the Engineer.

### **8.2 Payment for Job Lot Testing**

Payment for the work involved in the sampling, sample preparation and testing of a job lot in accordance with the requirements of Appendix 2 of this specification shall be as laid down in clauses 8.2.1 and 8.2.2 below, depending on the actual test results.

#### **8.2.1 Particle Size Distribution**

Should a job lot certified to comply with the acceptance requirements of this specification fall outside the particle size distribution specified in section 4, then all costs incurred by the

Engineer in sampling, sample preparation and testing shall be met by the Producer or Contractor as appropriate.

### 8.2.2 Assessment of Grade

The difference between the Job Lot Lime Grade as defined in clause 3.2 and the grade certified by the Producer for that material shall be used to assign the costs incurred in sampling, sample preparation and testing of the job lot. All costs shall be met by:

- (a) The Producer or Contractor where the Job Lot Grade downgrades the product to below Grade 85.
- (b) The Producer or Contractor where the Job Lot Grade downgrades the product by more than 5% from the certified grade, yet the Job Lot Grade is  $\geq 85$ .
- (c) The initiator of the requirement for job lot testing in all cases other than (a) and/or (b).

## 9. SPECIFIC CONTRACT REQUIREMENTS

### Lime for Use in Soil Stabilisation

- (1) Name of Contract
- (2) Type of Contract  
(Supply Only or Supply and Construct)
- (3) Material  
(Quicklime or Hydrated Lime)

#### 9.1 Quicklime (Contract for Supply Only of Quicklime)

Quantity of quicklime required ..... tonnes

#### 9.2 Hydrated Lime (Contract for Supply Only of Hydrated Lime)

Quantity of hydrated lime required ..... tonnes

## APPENDIX 1

### SAMPLING, SAMPLE PREPARATION AND TESTING FOR REGULAR CONTROL

#### 1. SCOPE

The grade of lime is fundamental to its use in stabilisation. A methodology for regular control sampling, sample preparation and testing for grade has therefore been defined herein to provide a uniform basis for assessment.

A regular control testing procedure for particle size distribution determination is not defined herein. Producers shall establish control procedures which take account of particle size distribution variability so as to provide suitable confidence of acceptance within the provisions for job lot evaluation.

#### 2. SAMPLING FOR REGULAR CONTROL OF THE GRADE

##### 2.1 General

Sampling shall be carried out before the quicklime or hydrated lime leaves the producer's plant.

Sampling shall conform to ASTM C50-00 (Reapproved 2006) "*Standard Practice for Sampling, Sample Preparation, Packaging and Marking of Lime and Limestone Products*".

##### 2.2 Regular Control Sampling of Quicklime

Frequency of sampling shall be either:

- (a) A minimum of daily from the production process; or
- (b) Per truckload of product.

In case (a) above, the unit of daily production from which incremental sub-samples are to be collected shall be every 60 minutes or less of continuous production.

Number of incremental sub-samples to be obtained and combined to form a single bulk sample shall be at least 10. Each incremental sub-sample shall be at least 1kg. These specific requirements for regular control sampling replace the comparable requirements recommended in clause 7.6 of ASTM C50-00 (2006).

##### 2.3 Regular Control Sampling of Hydrated Lime

Point of sampling shall be from a convenient location in the production process where the whole of production which contributes to the lime being supplied is represented.

Sampling shall conform to ASTM C50-00 (Reapproved 2006) "*Standard Practice for Sampling, Sample Preparation, Packaging and Marking of Lime and Limestone Products*".

**Frequency** of sampling shall be either:

- (a) A minimum of daily from the production process; or
- (b) Per truckload of product.

In case (a) above, the unit of daily production from which incremental sub-samples are to be collected shall be every 60 minutes or less of continuous production.

Each sub-sample shall be not less than 500 grams. The sub-samples for each day shall be combined to form a single bulk sample. The specific requirements for regular control sampling replace the comparable requirements recommended in clause 7.6 of ASTM C50-00 (2006).

### **3. SAMPLE PREPARATION FOR TESTING THE GRADE OF REGULAR CONTROL SAMPLES**

#### **3.1 General**

The reduction of bulk samples and preparation of samples for testing shall proceed in accordance with the requirements specified herein. Processing shall be carried out expeditiously to minimise recarbonation and hydration of materials.

On completion of sample preparation or if the preparation process is staged or delayed, the material to be retained for testing shall be placed in clean airtight dry containers labelled appropriately and sealed.

#### **3.2 Preparation of Quicklime Regular Control Samples**

The bulk quicklime control sample of clause 2.2 above of Appendix 1 shall be crushed if necessary to pass a test sieve of the maximum particle size specified in Section 4 of TNZ M/15, and reduced by means of a riffler, similar to that shown in Figure 1.2 of NZS 4402 Part 1:1986, to approximately 10kg (mass).

The 10kg sub-sample shall then all be crushed to pass a 4.75mm test sieve and by means of a riffler shall be reduced to approximately 2kg (mass).

A sub-sample of approximately 100g (mass) shall be obtained from the 2kg sample by means of a riffler and all of this material shall be ground to pass a 150µm test sieve and set aside for Available Lime Index testing (see clause 4 below).

#### **3.3 Preparation of Hydrated Lime Regular Control Samples**

The bulk hydrated lime sample described in clause 2.3 above of Appendix 1 shall be reduced to produce a sample of approximately 100 grams.

This material shall be ground, if necessary, to pass a 150µm test sieve and shall be set aside for Available Lime Index testing (see Section 4 below).

#### **4. TESTING THE GRADE OF REGULAR CONTROL SAMPLES**

The Available Lime Index test on samples extracted from the daily production process shall be in accordance with the test method defined in Section 28 of ASTM C25-06.

Utilisation of the reported available lime index of the control sample for certification by the Producer of the grade of quicklime and hydrated lime is described in Section 3 of TNZ M/15.



## APPENDIX 2

### SAMPLING, SAMPLE PREPARATION AND TESTING OF A JOB LOT

#### 1. SCOPE

This appendix details the sampling, sample preparation and testing procedure to be carried out on a job lot and is to be read in conjunction with TNZ M/15.

The requirement for testing of a job lot may be initiated by either the Producer, Contractor or the Engineer. In general, job lot testing will only be initiated when there is a perceived need to reassess the appropriateness of the characteristics certified.

#### 2. SAMPLING OF A JOB LOT

##### 2.1 General

Sampling procedure shall generally conform to the appropriate requirements of ASTM C50-00 (2006) except as modified by clause 2.2 and 2.3 below.

Incremental sub-samples shall in all cases be selected randomly or at random intervals as appropriate rather than at regular intervals.

Trucks or railcars shall be sampled from the belt that discharges to the truck or railcar. Sampling shall be in accordance with Section 8.8 of ASTM C50-00 (2006).

All bulk samples shall be accumulated and retained in sealed airtight containers.

##### 2.2 Job Lot Sampling of Quicklime

Point of sampling will be defined by the initiator (Producer, Contractor or Engineer) of the demand for job lot testing.

Job lot size will be defined by the initiator (Producer, Contractor or Engineer) of the requirement for job lot testing but shall not exceed 50t (mass).

Number of incremental sub-samples to be obtained and combined to form a single bulk sample shall be at least 2 for a job lot of up to 2t and at least 10 for a job lot of 50t with a linear variation between these limits. Each incremental sub-sample shall be at least 2kg

These specific requirements for a job lot sampling replace the comparable requirements recommended in clause 7.6 of ASTM C50-00 (2006).

The crushing and reduction of the sample shall be in accordance with clause 3 below.

## 2.3 Job Lot Sampling of Hydrated Lime

Point of sampling will be defined by the initiator of the demand for job lot testing.

Job lot size shall be defined by the initiator of the requirement for job lot testing but shall not exceed 50t (mass).

Number of incremental sub-samples to be obtained and combined to form a single bulk sample shall be at least 2 for a job lot of up to 2 tonnes and at least 10 for a job lot of 50 tonnes with a linear variation between these limits. Each incremental sub-sample shall be of at least 1kg.

When sampling from packages for consignments of 12 or more packages at least 10% of the packages must have sub-samples taken from them.

The above specific requirements for job lot sampling replace the comparable requirements recommended in clause 7.6 of ASTM C50-00 (2006).

Reduction of the bulk sample shall be in accordance with clause 3 below.

## 3. SAMPLE PREPARATION OF JOB LOT SAMPLES FOR TESTING

### 3.1 General

The reduction of bulk samples and preparation of samples for testing shall proceed in accordance with the requirements specified herein. Processing shall be carried out expeditiously to minimise recarbonation and hydration of materials.

On completion of sample preparation or if the preparation process is staged or delayed, the material to be retained for testing shall be placed in clean airtight dry containers labelled appropriately and sealed, in accordance with clause 7.3 of ASTM C50-00 (2006).

### 3.2 Preparation of Quicklime Job Lot Samples

Should the initiator of the demand for job lot testing require a particle size distribution test then triplicate 1.0kg (mass) sub-samples of the quicklime shall be obtained by means of a riffler, similar to that shown in Figure 1.2 of NZS 4402:Part 1:1986, from the bulk job lot sample of clause 2.2 above, Appendix 2. These samples shall be set aside for particle size distribution testing (see clause 4 below).

In order to obtain samples for the Available Lime Index test the remainder of the bulk sample shall be crushed if necessary to pass a test sieve of the maximum particle size specified in clause 4 of TNZ M/15 and reduced by means of a riffler to approximately 5kg (mass).

The 10kg sub-sample shall then all be crushed to pass a 4.75mm test sieve and by means of a riffler shall be reduced to triplicate samples each of approximately 1kg (mass).

The remaining step in the sample preparation process involves obtaining from each of the triplicate samples by means of a riffler a sub-sample of approximately 100g (mass) all of which shall be ground to pass a 150µm test sieve and set aside for Available Lime Index testing (see clause 4 below). This last step in the sample preparation process may be carried out by the initiator of the demand for job lot testing only on that particular sample from the triplicate group which will be tested by that party (see clause 4 below).

The two remaining 1kg samples of minus 4.75mm material shall be sealed in their respective containers. The balance of the sample preparation described in the preceding paragraph will be executed in due course by the testing agencies responsible for determine the Available Lime Index on the respective samples.

### 3.3 Preparation of Hydrated Lime Job Lot Samples

The job lot bulk sample of hydrated lime shall be reduced by means of a riffler, similar to that shown in Figure 1 of NZS 4402:Part 1:1980, to approximately 5kg.

This 5kg sub-sample shall be further reduced in the same manner to produce triplicate 200g (mass) and/or 100g (mass) samples to be set aside for particle size and Available Lime Index testing respectively as required (see clause 4 below). The triplicate 100g samples for Available Lime Index testing shall be ground, if necessary, to pass a 150µm test sieve.

## 4. TESTING OF JOB LOT SAMPLES

The individual triplicate samples of quicklime or hydrated lime shall be tested for particle size distribution in accordance with Appendix 3 of this specification and/or Available Lime Index in accordance with Section 28 of ASTM C25 - 06, as demanded by the initiator of the requirement for job lot testing.

One of the triplicate samples will be tested by a nominated agent of the initiator of the demand for testing and the other party may accept that result or elect to have the second of the triplicate samples tested by his own nominated agent. Should the latter occur, the mean of the results on the two tested samples shall be agreed to represent the characteristics of the quicklime. If agreement cannot be reached on this basis then the third and final triplicate sample shall be tested by a testing agency mutually agreed upon prior to testing and that single result shall be taken to represent the characteristics of the lime.

Subsequent to testing the first of the triplicate job lot samples, the initiator of the demand for job lot testing shall be responsible for storing the remaining two samples. These samples shall be available for uplifting by the other party for a period of not less than one week after the job lot test result has been advised to that party. Samples may be discarded after this period.

Utilisation of the reported results in assessment of quicklime or hydrated lime is described in Sections 4 and 5 of TNZ M/15.

## APPENDIX 3

### DETERMINATION OF QUICKLIME AND HYDRATED LIME JOB LOT SAMPLE PARTICLE SIZE DISTRIBUTION

#### 1. SCOPE

This method for the quantitative determination of the particle size distribution of quicklime or hydrated lime has been prepared in recognition of the breakdown during sieving which occurs with these soft materials.

#### 2. APPARATUS

An appropriate range of test sieves to BS 410 and which shall not be less than 300mm in diameter and appropriate receivers.

A balance readable to 0.1% and accurate to  $\pm 0.1\%$  of the test sample mass.

#### 3. PROCEDURE

(a) Weigh the test sample of quicklime or hydrated lime prepared in accordance with Appendix 2 of this specification (see Note 1).

Take the largest of the appropriate test sieves and its receiver ensuring that they are clean and dry and place the test sample on top of the sieve. Agitate the sieve by hand, avoiding violent movements, for no more than one minute or until no further material is passing through the sieve, whichever is shorter (see Notes 2 and 3).

Repeat (a) for the remaining appropriate test sieves.

Weigh and record to the nearest 0.1% of the mass of the test sample, the mass retained on each test sieve and the mass passing the finest test sieve.

Determine the mass of each size fraction to the nearest 0.1% of the mass of the test sample (see Note 4).

Calculate the mass of material passing each test sieve as a percentage of the original sample mass.

#### 4. REPORTING

Results shall be reported as the total percentage of material passing each test sieve to the nearest 1% (see Note 4).

#### NOTES

1. The weighing and subsequent sieving should be carried out expeditiously to avoid hydration or recarbonation of the lime products.

2. **The time has been limited to one minute in order to minimise the mechanical degradation to which lime products are susceptible.**
3. **Notwithstanding Note 2, it may be necessary to increase the sieving time on the finer sieves if overloading of a test sieve is suspected.**
4. **The sum of the mass retained on each test sieve and the mass passing the finest test sieve should not differ from the recorded mass of the original test sample by more than 2%. This should allow for both conventional losses and any chemical changes which occur during the testing procedure.**