Test Method

Lime Stabilised Earthworks Materials - Available Lime, Assigned CBR and Swell

RC 301.04

June 2017

1. Scope

This Test Method sets down the procedure for:

(a) Determining the design distribution rate of Available Lime to be added to an earthworks material to be lime stabilised; and

(b) Assignment of California Bearing Ratio (CBR) and Percent Swell of lime stabilised earthworks material.

Notes *:*

1. *This method is not applicable to lime stabilised pavement materials. Refer to VicRoads Test Method RC 330.01 -* Cementitious Binder and Granular Additive Content for the Stabilisation of Pavement Materials *for the laboratory procedure for the determination of binder content for the stabilisation for pavement materials.*
2. *For Earthworks Fill and Pavement Materials (not lime stabilised), Assigned CBR and Swell are determined in accordance with RC 324.01.*

2. Definitions

2.1. California Bearing Ratio (CBR)

Test value of a re-moulded specimen as determined by AS 1289.6.1.1.

2.2. Percent Swell

Test value of a re-moulded specimen as determined by AS 1289.6.1.1.

2.3. Assigned CBR

The CBR value assigned in accordance with this method to a lime stabilised earthworks material.

2.4. Assigned Percent Swell

The percent swell assigned in accordance with this method to a lime stabilised earthworks material, obtained in conjunction with the assigned CBR test.

2.5. Available Lime Index (ALI)

The content of pure calcium oxide or calcium hydroxide in quick lime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS 4489.6.1.

2.6. Lime

Quicklime or hydrated lime supplied by the manufacturer.

2.7. Design Content of Available Lime

The amount of Available Lime (% of dry mass of earthworks material) required to achieve the specified test requirements for the lime stabilised material plus an allowance for variability in mixing.

2.8. Design Distribution Rate of Available Lime

The theoretical spread rate of Available Lime (kg/m^2) if a lime with an ALI of 100% were to be used having regard to the compacted depth and the Maximum Dry Density (MDD) of the material to be treated.

3. Test Area and Sampling

3.1. Material record

Record material source and description, placed location, layer, and nominal size.

3.2. Selection of Test Area

The bounds of the test area, or materials source, or the preliminary trial site shall be defined. Any areas or material to be excluded from the lot shall be designated.

Material may be mixed and stockpiled prior to samples being taken to simulate the degree of mixing normally achieved when the material is supplied to a road works project.

A preliminary trial of the proposed stabilising operation may be conducted, when agreed or specified for the works, in which case the Lime Spreading Rate shall be determined and recorded.

3.3. Sample Site Selection

Select the required number (n = 3) of essentially randomly located test sites within the test area in accordance with RC 316.10, or AS 1289.1.4.2 (sampling is normally prior to stabilisation works).

Record the test site locations.

3.4. Sampling

Obtain the three samples from the test area or earthworks materials source, at the sites selected above, in accordance with AS 1289.1.2.1. The samples taken shall be representative of the material to be lime stablised for earthworks.

Material may be mixed and stockpiled prior to samples being taken to simulate the degree of mixing normally achieved when the material is supplied to a road works project.

The depth at which samples are taken shall be determined in a manner similar to that for locating the lateral position of the sampling site using the depth of expected excavation at the selected site instead of the width of the lot.

3.5. Pretreatment

If appropriate, material that breaks down or fractures during compaction shall be preconditioned in the laboratory by repeated compaction in accordance with RC 301.05 using three cycles of compaction. Test reports for CBR where this pre-treatment is applicable must state that three cycles of compaction to RC 301.05 was used.

As an alternative to laboratory pre-conditioning, the material may be placed in a field trial and compacted to meet the specified minimum Density Ratio. If the amount of oversize material precludes density testing, the material shall be compacted using the rolling routine proposed to compact the material in the road construction works and then proof rolled in accordance with VicRoads Standard Specification Section 173 - *Examination and Testing of Materials and Work* prior to sampling.

3.6. Preparing Samples for Testing

Preparation of the samples shall be in accordance with AS 1289.1.1.

4. Testing

4.1. Properties of Raw Material

For each sample obtained and prepared as detailed in Clause 3, determine:

(a) Optimum Moisture Content (OMC) and MDD in accordance with AS 1289.5.1.1;

(b) Particle Size Distribution in accordance with AS 1289.3.6.1;

(c) Liquid Limit in accordance with AS 1289.3.2.1;

(d) Plastic Limit in accordance with AS 1289.3.2.1; and

(e) Plasticity Index in accordance with AS 1289.3.3.1.

4.2. Minimum Content of Available Lime Required

(a) Determine the ALI of the lime to be used for the test in accordance with AS 4489.6.1, or the lime supplier shall provide a NATA-endorsed certificate stating the ALI of their product.

(b) For each sample (after pre-conditioning) determine the percentage by mass of lime (L) needed to saturate the whole soil in accordance with RC 131.01.

(c) For the sample requiring the highest percentage of lime by mass (L_2) needed to saturate the whole soil, calculate the minimum content of available lime required (AL_{MIN}), in percent, using the following equation:

$$AL_{MIN} = L_2 \times \left(\frac{ALI}{100}\right) + 0.5\ \%, \quad \text{where}$$

AL_{MIN} = the minimum content of available lime required (AL_{MIN}), in percent

L_2 = percentage by mass of lime needed to saturate the whole soil in accordance with RC 131.01, in percent

ALI = Available Lime Index

(d) If the minimum content of Available Lime calculated in step (c) is less than 1.5% by mass, calculate the percentage of lime by mass ($L_{1.5}$) required to produce a minimum of Available Lime content of 1.5% by mass, using the following equation:

$$L_{1.5} = 1.5 \times \left(\frac{100}{ALI}\right), \quad \text{where}$$

$L_{1.5}$ = percentage by mass of lime required to produce a minimum of Available Lime content of 1.5% by mass, in percent

ALI = Available Lime Index

(e) The minimum percentage of lime (L) to be added for testing shall be the higher value of those obtained at step (c) and (d).

4.3. Addition of Lime and Pre-conditioning of Samples

(a) For each sample of material to be compacted for CBR testing, adjust the moisture content to OMC.

(b) Prepare the material in accordance with RC 301.03 Clause 4.2 (e) to Clause 4 (i) using the minimum percentage of lime determined in Clause 4.2 (e) above.

(c) Between 48 and 72 hours after compaction of the samples, break up each sample over a 10 mm screen.

4.4. CBR and Percent Swell Test

Determine the CBR and Percent Swell, for each sample, after 4 days soaking in water, as detailed in AS 1289.6.1.1 and, when appropriate, the following specific requirements :

(a) After completing sample breakup at Clause 4.3 (c), immediately compact a CBR specimen from each sample, using Standard compactive effort, as detailed in AS 1289.6.1.1.

(b) The moisture content for compaction of the test specimens shall be between 95% and 105% of OMC as determined in Clause 4.1.

(c) The surcharge to be applied during the soaking period shall be 4.5 kg. This surcharge shall be in addition to the mass (1.0 kg) of the stem and perforated plate placed on the specimen during soaking.
The total mass applied during the soaking period shall be 5.5 kg.

(d) The surcharge to be applied during the CBR penetration test procedure shall be 4.5 kg. The surcharge shall be applied in accordance with Clause 8(a) of AS 1289.6.1.1.

(e) Individual values of CBR and Percent Swell shall not be rounded before calculating mean values.

5. Calculations

5.1. Assigned CBR

(a) Rank in ascending order, the three (3) CBR test values obtained from the three lime stabilised samples.

(b) Select the two lowest soaked CBR test values.

(c) Calculate the mean of the two lowest soaked CBR test values.

(d) The Assigned CBR of the lime stabilised material shall be one-third of the mean value of the two lowest soaked CBR test values.

5.2. Assigned Percent Swell

(a) Rank in ascending order, the three (3) Percent Swell test values obtained from the three lime stabilised samples.

(b) Select the two highest Percent Swell test values.

(c) Calculate the mean of the two highest percent swell values.

(d) The Assigned Percent Swell value shall be twice the mean value of the two highest percent swell values.

6. Determination of the Design Content of Available Lime Required

(a) If the Assigned CBR determined in Clause 5.1 is less than that required, repeat the steps of Clauses 4.3 and 4.4 by adding increments of lime (suggest 1% lime increments) until the Assigned CBR as determined in Clause 5.1 meets the required CBR. Record the relevant amount of lime, as percent by mass.

(b) If the Assigned Percent Swell determined in Clause 5.2 is greater than that specified or required, repeat the steps of Clauses 4.3 and 4.4 by adding increments of lime (suggest 1 % lime increments) until the assigned Percent Swell as determined in Clause 5.2 meets the specified Percent Swell requirements. Record the relevant amount of lime, as percent by mass.

(c) Select the highest amount of lime (L) (% by mass) determined in Clause 6(a) or 6(b).

(d) Calculate the Design Content (% by mass) of Available Lime (AL_{DC}) for the Soil/Lime mixture required from the following equation:

$$AL_{DC} = (L) \times \left(\frac{ALI}{100} \right) + 0.5\%$$

(e) AL_{DC} shall not be less than AL_{MIN} calculated in Section 4.2(c) above nor shall it be lower than 1.5% by mass.

7. Design Distribution Rate of Available Lime

Calculate the Design Distribution Rate of Available Lime for the compacted depth of earthworks material being stabilised as follows:

(a) Obtain the MDD (tonnes/m^3) of the material to be stabilised as the average of the two highest values determined at Clause 4.1(a).

(b) Obtain the compacted depth (T) (millimetres) of the earthworks material to be lime stabilised.

(c) Calculate the Design Distribution Rate of Available Lime (kg/m^2) (AL_{DDR}) from the following equation:

$$AL_{DDR} = \left(MDD \times AL_{DC} \times T \right) / 100$$

Note: *The required field spread rate in kg/m^2 of lime at the site is calculated in accordance with the procedure specified in VicRoads Standard Specification Section 290* - Lime Stabilisation of Earthworks Material *once the ALI of the lime delivered to the site is known.*

8. Report

The test report shall include the following information:

(a) The source and description of the material, including "lime stabilised earthworks material".

(b) Location of test sites, and date of sampling.

(c) The report number(s), if applicable, to the test results used in the assigned value calculations.

(d) The Assigned CBR value, in percent, rounded in accordance with the reporting requirements of AS 1289.6.1.1, Clause 10(a).

(e) The Assigned Percent Swell value, in percent, to the nearest 0.5 %.

(f) The date the values were assigned.

(g) The amount of lime (L), in percent by mass, to the nearest 0.1 %.

(h) The Design Content of Available Lime (AL_{DC}), in percent by mass, to the nearest 0.1 %.

(i) The Design Distribution Rate of Available Lime (AL_{DDR}), in kg/m^2, to the nearest 0.1 kg/m^2.

(j) Reference to this Test Method (RC 301.04).

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VicRoads Test Method - Revision Summary

RC 301.04 – Lime Stabilised Earthworks Materials – Available Lime, Assigned CBR and Swell

Date	Clause	Description of Revision	Authorised by
June 2017	4.4(d)	Surcharge consistent with AS 1289.6.1.1	Manager – Construction Materials
October 2016	4.2(d)	step (c) - correction	Manager – Construction Materials
April 2016	Full method	New Issue – text from previous CoP RC 500.23	Manager – Construction Materials