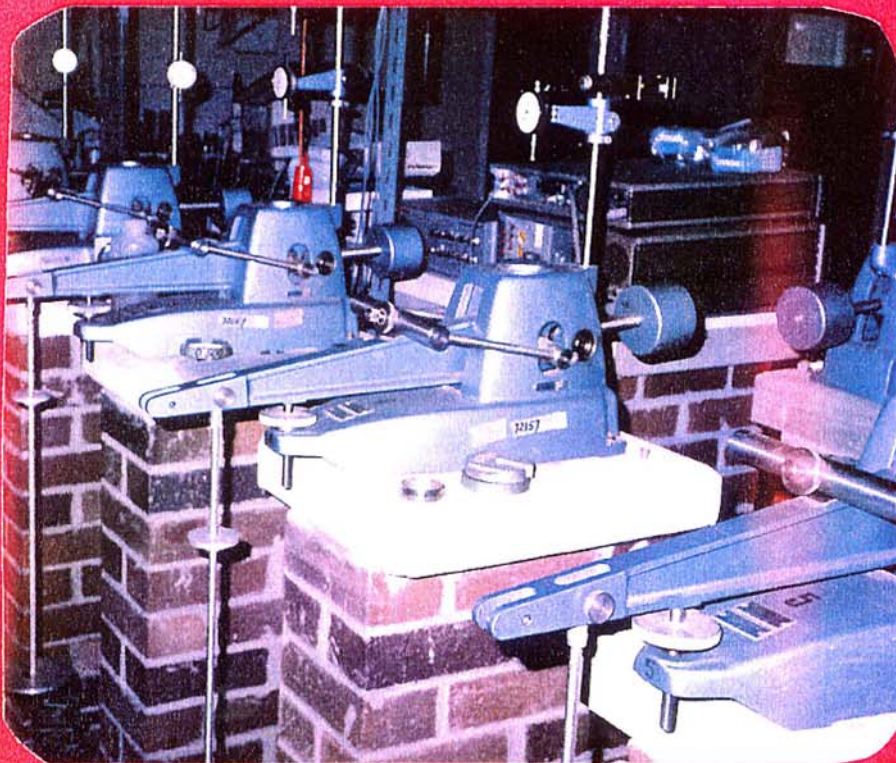
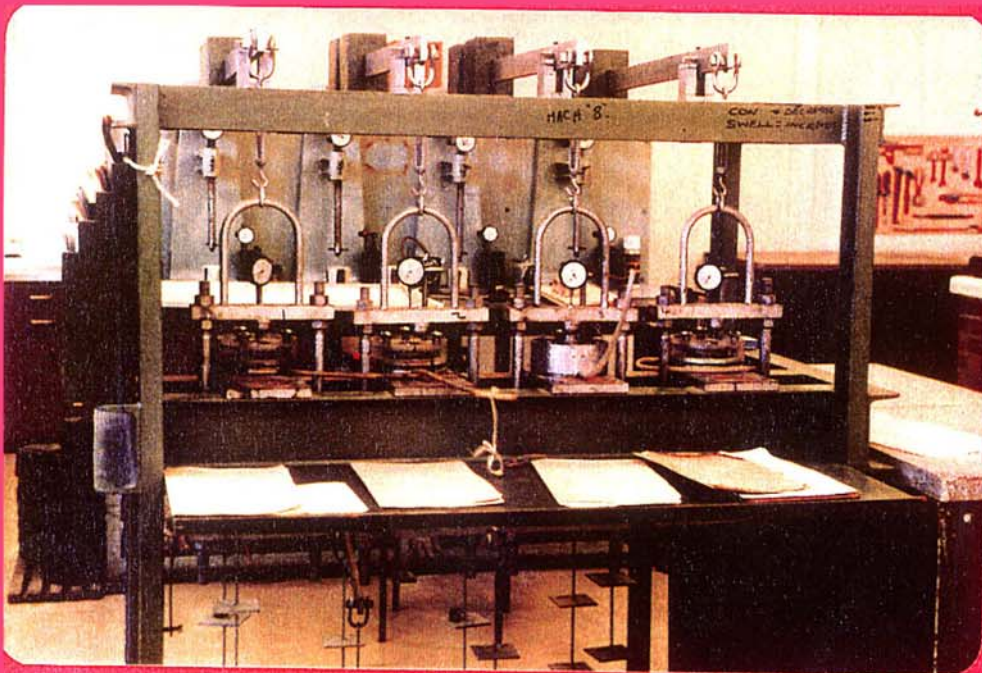


# SECTION 2

## SAMPLING AND TESTING

### SOILS





Road Projects Division

INDEX OF TEST METHODS

TEST METHOD	REVISED DATE	SECTION 2 - SAMPLING & TESTING SOILS
NTTM 201.2	06 / 03	Modified Compaction - Lime Stabilised Materials.
NTTM 201.3	06 / 03	Modified Compaction - Cement Stabilised Materials.
NTTM 201.4	06 / 03	Modified Compaction – Bituminous Stabilised Materials.
NTTM 202.2	06 / 03	California Bearing Ratio - Lime Stabilised Materials.
NTTM 202.3	06 / 03	California Bearing Ratio – Cement Stabilised Materials.
NTTM 203.1	06 / 03	Unconfined Compressive Strength.
NTTM 204.1	06 / 03	Cement Content of Stabilised Materials - Heat of Neutralisation.
NTTM 204.5	06 / 03	Determination of the Lime Saturation Point of Stabilised Materials - pH Method.
NTTM 204.6	06 / 03	Available Calcium Oxide or Calcium Hydroxide in Lime.
NTTM 204.7	06 / 03	Rate of Spread of Lime or Cement.
NTTM 204.8	06 / 03	Stabiliser Distribution.
NTTM 205.1	06 / 03	Durability Cement Stabilised Materials.
NTTM 211.1	06 / 03	Plate Bearing Test.
NTTM 214.1	06 / 03	Visual Classification.
NTTM 215.1	06 / 03	Standard Ball Penetration Test.
NTTM 216.1	06 / 03	Measurement of Layer Thickness.
NTTM 217.1	06 / 03	Particle Size Distribution – Oversize Material



## MODIFIED COMPACTION - LIME STABILISED MATERIALS

### 1. SCOPE

This test method sets out the procedures for determination of the relationship between Dry Density and Moisture Content for mixtures of Materials and Lime stabilised in the field, or materials stabilised in the laboratory.

This method is applicable to materials having no more than 20% retained on the 37.5mm AS sieve.

This test method has been adapted from NSW RTA Test Method T130.

### 2. APPARATUS

As described in Australian Standard AS1289.5.2.1.

### 3. PREPARATION OF SAMPLE

Prepare the sample in accordance with the procedure prescribed in AS1289.2.1.1, AS1289.5.2.1 and AS1289.5.4.1.

### 4. PROCEDURE

#### 4.1 Stabilised in the Field

- (a) The sample shall be taken within one hour from the time from the completion of mixing in-situ.
- (b) Immediately after the sample has been taken it shall be sealed in an airtight container, sheltered, and transported as soon as practicable to the laboratory for processing.
- (c) The procedure is to be commenced immediately the sample is removed from the airtight container.
- (d) Prepare the specimen in accordance with AS1289.5.2.1 and AS1289.5.4.1.
- (e) Cure the sample overnight.
- (f) Compact the sample in accordance with AS1289.5.2.1.
- (g) The compaction of the specimen, is to be completed within 48 hours of delivery for plant mixed material or, in the case of in-situ work, within 48 hours of the completion of mixing.

#### 4.2 Stabilised in the Laboratory

- (a) Follow AS1289.5.2.1 Procedure (a) to (d) inclusive.
- (b) Take one of the portions and determine the mass to the nearest 1g. Screen on a 4.75mm sieve. All material retained on the 4.75mm AS sieve shall be soaked for at least one hour and then surface dried.
- (c) Incorporate the prescribed additive as follows:
  - i. Hydrated Lime: Add the required amount of hydrated lime, calculated as a percentage of the total dry mass of the portion as determined in 4(b) to the material passing the 4.75mm AS sieve and thoroughly mix the dry materials to a uniform colour.



Road Projects Division

TEST METHOD : NTTM 201.2

REVISED DATE : 06/03

SHEET : 2 OF 2

- ii. Quicklime: Add the required amount of ground quicklime, calculated as a percentage of the total dry mass of the portion determined in 4(b), to the material passing the 4.75mm AS sieve and thoroughly and carefully mix the dry materials to a uniform colour. Add a quantity of water equal to one-half to two-thirds of the mass of quicklime added to the material. Carefully mix, observing the safety precautions set out in Note 5. Slaking will occur rapidly with the generation of heat. The magnitude of the reaction will depend on the amount of quicklime present. Cover the mixture and allow to stand for about 10 minutes. Remix to break up any lumps that may have formed.

**See Note 5 for safety precautions related to the use of quicklime.**

- (d) Add the required quantity of water to the mix. Select the quantities of water to be added so that the soil optimum moisture content is straddled and the moisture steps are not excessive for the soil type.
- (e) Incorporate the saturated surface dry material retained on the 4.75mm sieve and remix.
- (f) Repeat this procedure with the remaining portions of material.
- (g) Place the mixture in a container and seal. Allow the mixture to cure overnight at room temperature.
- (h) Remix the material and adjust moisture if necessary.
- (i) Compact the material in accordance with AS1289.5.2.1, procedure (g) to (q) inclusive.

## 5. CALCULATIONS

In accordance with AS1289.5.2.1 and AS1289.5.4.1.

## 6. REPORTING

In accordance with AS1289.5.2.1 and AS1289.5.4.1.

### **NOTES ON TEST:**

1. Lime used in laboratory investigations should be the same type from the same source of supply or manufacture as the lime proposed for use in the field. Unless otherwise specified or approved, quicklime and hydrated lime shall comply with Australian Standard 1672.1 – Limes and Limestone – Limes for Building.
2. Hydrated lime is the most common form of lime used in lime stabilisation of road materials. It is usually supplied in the form of a fine, white powder and consists essentially of calcium hydroxide. No preparation is required.
3. Quicklime is supplied as ground quicklime, crushed or pebble quicklime or as lumps, and consists essentially of calcium oxide. Unless supplied in ground form, the material should be ground to pass a 2.36mm AS sieve and stored in an air-tight container and protected from moisture until used.
4. Hydrated lime is relatively safe but care is required to protect the eyes when using hydrated lime.
5. **Quicklime may be dangerous in the presence of moisture because of its highly caustic nature. Even small amounts of perspiration on the skin may react with quicklime and cause skin burns. Quicklime is especially dangerous to the eyes. Safety glasses, long-sleeved coats and gloves should be worn, and protective cream applied to the hands and arms as required, when using quicklime in the laboratory.**



## MODIFIED COMPACTION - CEMENT STABILISED MATERIALS

### 1. SCOPE

This test method sets out the procedures for the determination of the relationship between Dry Density and Moisture Content for Materials stabilised in the field and sampled prior to compaction, or materials stabilised in the laboratory.

This method is applicable to materials having not more than 20% retained on the 37.5mm AS sieve.

### 2. APPARATUS

As described in Australian Standard AS1289.5.2.1.

### 3. PREPARATION OF SAMPLE

Prepare the sample in accordance with the procedure prescribed in AS 1289.1.1, AS 1289.2.1.1, AS 1289.5.2.1 and AS 1289.5.4.1.

### 4. PROCEDURE

#### 4.1 Stabilised in the Field

- (a) The sample shall be taken within one hour from the time from the completion of mixing in-situ.
- (b) Immediately after the sample has been taken it shall be sealed in an airtight container, sheltered, and transported as soon as practicable to the laboratory for processing.
- (c) The procedure is to be commenced immediately the sample is removed from the airtight container.
- (d) The compaction of the specimen, is to be completed within 2 hours of delivery for plant mixed material or, in the case of in-situ work, within 2 hours of the completion of mixing.
- (e) Compact the material in accordance with AS 1289.5.2.1.

#### 4.2 Stabilised in the Laboratory

- (a) Follow AS 1289.5.2.1 procedure (a) to (d) inclusive.
- (b) Take one of the portions and determine the mass to the nearest 1g. Screen on a 4.75mm sieve. All material retained on 4.75mm sieve shall be soaked for at least one hour and then surface dried.
- (c) Add the required amount of cement (calculated as a percentage of the dry mass of the portion determined in 4.2 (b) to the material passing the 4.75mm AS sieve and thoroughly mix the dry materials to a uniform colour.
- (d) Repeat this procedure for the remaining portions of materials.
- (e) Selecting one point at a time, thoroughly mix each portion with a suitable amount of water using small increments and mixing well between additions. Select the quantities of water to be added so that the soil optimum moisture content is straddled and the moisture steps are not excessive for the soil type (Note 4).



**Road Projects Division**

---

TEST METHOD : NTTM 201.3

REVISED DATE : 06/03

SHEET : 2 OF 2

- (f) Incorporate the saturated surface dry material retained on the 4.75mm AS sieve and remix. Cover the mixture and allow to stand for not less than five minutes but not more than ten minutes.
- (g) Compact the material in accordance with AS 1289.5.2.1. Procedure (g) to (q) inclusive.

**5. CALCULATIONS**

In accordance with AS 1289.5.2.1.

**6. REPORTING OF RESULTS**

Report in accordance with AS 1289.5.2.1 and AS 1289.5.4.1.

**NOTES ON TEST:**

1. Time for Completion of Test:

The compaction of each portion must be completed within 20 minutes of mixing water into the material containing cement.

2. Mixing:

It is important that the water is thoroughly mixed into the soil since inadequate mixing gives rise to variable test results.

3. Cement used in laboratory investigations should be the same type from the same source of supply or manufacture as the cement proposed for use in the field. Unless otherwise specified or approved, the cement should be Type GP or GB complying with the requirements of AS 3972 - Portland and Blended Cements.
4. Cement should be stored in sealed containers and protected from moisture until used. Cement should not be used for laboratory investigations after being stored for a period of three months or more.



## MODIFIED COMPACTION - BITUMEN STABILISED MATERIALS

### 1. SCOPE

This test method sets out the procedures for the determination of the relationship between dry density and moisture content for mixtures of soil, gravel or crushed rock material and bitumen, cut-back bitumen, bitumen emulsion, or tar.

This method is applicable to materials with not more than 20% retained on the 37.5mm A.S. Sieve.

This test method has been adapted from NSW RTA Test Method T150.

### 2. APPARATUS

As described as AS1289.5.2.1

### 3. PREPARATION OF SAMPLE

- (a) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample at a temperature not exceeding 50°C.
- (b) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample was screened on a 4.75mm A.S. sieve only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking down sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with the rubber pestle.
- (c) Prepare the sample and select the mould size in accordance with AS 1289.5.2.1 and AS 1289.5.4.1
- (d) Obtain by quartering or riffing six 3000g portions of the prepared sample.

### 4. BITUMINOUS MATERIALS

- (a) Bituminous materials used in laboratory investigations should be of the same type and from the same source of supply or manufacture as the materials proposed for use in the field. Unless otherwise specified or approved the bituminous materials should comply with the requirements of the appropriate Australian Standard (i.e. Bitumen, Cut Back Bitumen, Bitumen Emulsion, or Tar).
- (b) Where bitumen emulsion is specified or approved for use in investigations in relation to stabilisation or modification of road materials, the water used in the test should be from the same source as that proposed for use in the field.

### 5. ADDITION OF THE BITUMINOUS MATERIAL

#### (i) DETERMINATION OF THE DESIRABLE VISCOSITY AND MOISTURE CONTENT FOR THE ADDITION OF BITUMEN OR CUT BACK BITUMEN

- (a) Take one of the 3000g portions of the sample obtained in 3 (d) and quarter or riffle it to obtain 6 to 8 portions, each about 300g.



Road Projects Division

---

TEST METHOD : NTTM 201.4

REVISED DATE : 06/03

SHEET : 2 OF 3

- (b) Take one of the 300g portions of soil, add sufficient water to dampen the soil, mix thoroughly and add a small quantity of bitumen that has been heated as necessary to produce a "pourable" condition. Mix with a trowel in an attempt to produce a uniform mix. If the viscosity is unsuitable for mixing, balls of unmixed bitumen will form. When this happens it is necessary to cut back the bitumen with power kerosene starting from 5 per cent cutter and increasing by 2 per cent increments.
- (c) To another 300g portion add a measured quantity of water (but do not exceed optimum moisture content at this stage) and add a small amount of cut-back bitumen. Mix thoroughly with a trowel and note ease (or difficulty) of mixing.
- (d) Repeat procedures (b) and (c) with increases in moisture content of the soil and/or the proportion of cutter in the bitumen until conditions for satisfactory mixing are determined.
- (e) Record the moisture content of the soil and the cutter content of the bitumen at which satisfactory mixing occurred.
- (f) Adopt the soil moisture content and cutter content of the bitumen recorded in (e) in the mixtures to be tested in accordance with this Test Method.
- (g) Add the cut back bitumen to the moist soil in small quantities, mixing thoroughly after each addition, until the required amount of bitumen has been added to the soil.

**( ii ) DETERMINATION OF THE DESIRABLE VISCOSITY AND MOISTURE CONTENT FOR THE ADDITION OF TAR**

- (a) Adopt a similar procedure to that described for bitumen above except that, instead of fluxing with kerosene, different grades of tar should be used.
- (b) Add the desired grade of tar to the moist soil in small quantities, mixing thoroughly after each addition until the required amount of tar has been incorporated in the soil.

**( iii ) ADDITION OF BITUMEN EMULSION**

- (a) Dampen the test portion to a moisture content of approximately 4% to 5%.
- (b) Calculate the additional quantity of water to be added to bring the emulsion/soil mix to the desired moisture content. For this purpose the water content of bitumen emulsion shall be taken as 45 per cent by mass.
- (c) Dilute the bitumen emulsion by adding at least half the additional water to the bitumen emulsion. Add the remainder of the additional water to the soil portion.
- (d) Add the diluted bitumen emulsion to the soil portion in small quantities mixing thoroughly after each addition until the required amount of bitumen emulsion has been incorporated in the soil.

**6. PROCEDURE**

- (a) Take one of the portions and determine the mass to the nearest 1g. Screen on a 4.75 mm A.S. sieve. All material retained on the 4.75mm A.S. sieve shall be soaked for at least one hour and then surface dried.
- (b) Bring the soil to the moisture content and add the bituminous material as described in Section 5.
- (c) Compact the mixture into the mould in accordance with AS 1289.5.2.1.



Road Projects Division

TEST METHOD : NTTM 201.4

REVISED DATE : 06/03

SHEET : 3 OF 3

- (d) Repeat processes (a) to (c) with the other portion adding the same amount of binder each time but increasing the quantity of water for each successive portion to provide the following approximate ranges:
  - (i) Sandy Materials: 7 to 15 percent in steps of 2 percent.
  - (ii) Clayey Materials: 12 to 24 percent in steps of 4 percent.
- (e) Repeat the procedure for each of the specified additive contents.

**7. CALCULATIONS**

Perform calculations in accordance with AS1289.5.2.1.

**8. REPORTING**

Report the following results for each bitumen content as appropriate:

- (a) Type and source of bituminous material.
- (b) Additive content.
- (c) Amount of cutter used (if any) and moisture content at which binder was added.
- (d) Source of water if bitumen emulsion is used.
- (e) Maximum Dry Density in  $t/m^3$  to the nearest  $0.01 t/m^3$ .
- (f) Optimum moisture content to the nearest 0.5%.

**9. TECHNIQUES**

- (a) The range of moisture contents required will vary according to the type of material to which the binder has been added. As a guide, the Plastic Limit gives an indication of the approximate upper limit of the range. In some cases it may be advisable to use increments of 2 per cent or less.
- (b) If difficulty is experienced in incorporating bitumen emulsion into the soil, an additive compatible with emulsion may be required.

eg. Anionic emulsions **must** be diluted with water of an alkaline nature. This may be achieved by the addition of 0.05 - 0.10% household detergent or phosphate softener (Calgon or equivalent) to the water before mixing with the emulsion.

Cationic emulsions **must** be diluted with water of an acidic nature. This may be achieved by the addition of 1% solution of hydrochloric acid (muriatic acid) or 0.05% by weight of amine salt, in a minimal amount just sufficient to acidify the local water.

If such an additive is found necessary, the type and quantity used should be recorded in the test report.

- (c) Difficulties may be experienced in the use of cut-back bitumen when mixed with road materials because of the slow rate of evaporation of cutter oil. The amount of cutter added should therefore be kept to a minimum.



## CALIFORNIA BEARING RATIO - LIME STABILISED MATERIALS

### 1. SCOPE

This test method sets out the procedure for the determination of the California Bearing Ratio for mixtures of materials modified or stabilised with lime, in the field or in the laboratory.

This test method has been adapted from NSW RTA Test Method T132.

### 2. APPARATUS

As described in Australian Standard AS 1289.6.1.1

### 3. PREPARATION OF SAMPLE

- (a) Prepare the sample in accordance with the procedure prescribed in AS1289.1.1
- (b) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample at a temperature not exceeding 50°C.
- (c) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample were screened on a 4.75mm AS sieve only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil.
- (d) Weigh the sample to be tested, then screen the sample on a 19.0mm AS sieve, weigh and determine the percentage retained on wet mass basis. Discard material retained.
- (e) Thoroughly remix all material passing the 19.0mm AS sieve and reduce as necessary by quartering or riffing to provide not less than 7,000g of material for preparation of a California Bearing Ratio specimen.
- (f) Where the moisture content of the material being tested is judged to be well below optimum, curing, after initial addition of water may be required. Such initial curing must be carried out prior to the addition of lime.
- (g) Determine the moisture content of a subsample of about 300g after addition of water if applicable.

### 4. PROCEDURE

#### 4.1 Stabilised in the Field

- (a) The sample shall be taken within one hour from the time from the completion of mixing in-situ.
- (b) Immediately after the sample has been taken it shall be sealed in an airtight container, sheltered, and transported as soon as practicable to the laboratory for processing.
- (c) The procedure described in Clause 3 is to be commenced immediately the sample is removed from the airtight container.
- (d) Determine the Maximum Modified Dry Density and Optimum Moisture Content in accordance with NTTM 201.2.
- (e) Incorporate sufficient water to bring the sample to Optimum Moisture Content. Place the mixture in an air tight container and seal. Cure the specimen overnight.
- (f) Compact the specimen in accordance with AS 1289.6.1.1
- (g) The compaction of the specimen is to be completed within 24 hours of delivery for plant mixed material or, in the case of in-situ work, within 24 hours of the completion of mixing. To achieve this time frame it may be necessary to estimate the Optimum Moisture Content based on wet density and added moisture.



Road Projects Division

TEST METHOD : NTTM 202.2

REVISED DATE: 06/03

SHEET : 2 OF 2

**4.2 Stabilised in the Laboratory**

- (a) Take a test portion of sufficient size (prepared as per Clause 3 above) and determine its mass to the nearest 1g. Calculate the required amount of additive as a percentage by dry mass. Determine the required amount of additive to the nearest 1g.
- (b) Incorporate the prescribed additive as follows: -
  - i. Hydrated Lime: Add the required amount of hydrated lime and thoroughly mix the dry materials to a uniform colour.
  - ii. Quicklime: Add the required amount of quicklime and thoroughly mix the dry materials to a uniform colour. Add a quantity of water equal to about two thirds of the mass of quicklime added to the material. Carefully mix as necessary, observing the safety precautions set out below. Slaking will occur rapidly with generation of heat. The magnitude of the reaction will depend on the amount of quicklime present. Cover the mixture and allow to stand for 10-15 minutes. Remix to break up any lumps, which may have formed.  
**See Note 5 for safety precautions related to the use of quicklime.**
- (c) Incorporate sufficient water to provide the Optimum Moisture Content appropriate for the intended compactive effort, as determined by Test Method NTTM 201.2, for the particular lime additive content. Place the mixture in a container and seal. Allow the mixture to cure overnight at room temperature.
- (d) Remove the mixture from the container. Remix, determine its moisture content from a 100g portion using a rapid method and adjust the moisture content, if necessary, to that provided in 4.2(c) above.
- (e) Compact the material in accordance with AS 1289.6.1.1

**5. CALCULATIONS**

Conduct calculations in accordance with AS 1289.6.1.1.

**6. REPORTING**

- (a) Report in accordance with AS 1289.6.1.1.
- (b) Report the Bearing Ratio at 2.5mm and 5.0mm. In all cases the adopted CBR value will be that at 2.5mm.

**NOTES ON TEST:**

- 1. Lime used in laboratory investigations should be the same type from the same source of supply or manufacture as the lime proposed for use in the field. Unless otherwise specified or approved, quicklime and hydrated lime shall comply with Australian Standard 1672.1 – 1997 – Limes and Limestone – Limes for Building.
- 2. Hydrated Lime is the most common form of lime used in lime stabilisation of road materials. It is usually supplied in the form of a fine, white powder and consists essentially of calcium hydroxide. No preparation is required.
- 3. Quicklime is supplied as ground quicklime, crushed or pebble quicklime, and consists essentially of calcium oxide. Unless supplied in ground form, the material should be ground to pass a 2.36mm AS sieve and stored in an air tight container and protected from moisture until used.
- 4. Hydrated lime is relatively safe but care is required to protect the eyes when using hydrated lime.
- 5. **Quicklime may be dangerous in the presence of moisture because of its highly caustic nature. Even small amounts of perspiration on the skin may react with quicklime and cause skin burns. Quicklime is especially dangerous to the eyes. Safety glasses, long sleeved coats and gloves should be worn, and protective cream applied to the hands and arms as required, when using quicklime in the laboratory.**



## CALIFORNIA BEARING RATIO - CEMENT STABILISED MATERIALS

### 1. SCOPE

This test method sets out the procedure for the determination of the California Bearing Ratio of mixtures of materials and cement modified or stabilised in the laboratory.

The procedures have been adapted from NSW RTA Test Method T132.

### 2. APPARATUS

As described in Australian Standard AS1289.6.1.1.

### 3. PREPARATION OF SAMPLE

- (a) Prepare the sample in accordance with the procedure prescribed in AS1289.1.1
- (b) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample at a temperature not exceeding 50°C.
- (c) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample were screened on a 4.75mm AS sieve only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with the rubber pestle.
- (d) Weigh the sample to be tested, then screen the sample on a 19.0mm AS sieve, weigh and determine the percentage retained on wet mass basis. Discard material retained.
- (e) Thoroughly remix all material passing the 19.0mm AS sieve and reduce as necessary by quartering or riffing to provide not less than 7,000g of material for preparation of a California Bearing Ratio specimen.
- (f) Where the moisture content of the material being tested is judged to be well below optimum, curing, after initial addition of water may be required. Such initial curing must be carried out prior to the addition of cement.
- (g) Determine the moisture content of a subsample of about 300g after addition of water if applicable.

### 4. PROCEDURE

- (a) Take a test portion of sufficient size (as prepared above) and determine its mass to the nearest 1 g. Calculate the required amount of cement as a percentage by dry mass. Weigh out the required amount of cement to the nearest 1 g.
- (b) Add the cement to the material and thoroughly mix the dry materials to a uniform colour. Add the quantity of water necessary to provide the optimum moisture content appropriate for the intended compactive effort for the particular cement content. Thoroughly mix. Cover the mixture and allow to stand for not less than 5 minutes and not more than 10 minutes. Remix the materials and break up any lumps that may have formed.
- (c) Place the mixture in a sealed container and allow to cure at a temperature of 23°C ± 2°C for 50-60min. The specimen should be moulded approximately 60-75 minutes after commencement of mixing.
- (d) Compact the material in accordance with AS1289.6.1.1.

### 5. CALCULATIONS

Calculate in accordance with AS1289.6.1.1.



---

**Road Projects Division**

---

TEST METHOD : NTTM 202.3

REVISED DATE : 06/03

SHEET : 2 OF 2

**6. REPORTING**

1. Report in accordance with AS1289.6.1.1
2. Report the Bearing Ratio at 2.5mm and 5.0mm. In all cases the adopted CBR value will be that at 2.5mm.

**NOTES ON TEST:**

1. Cement used in laboratory investigations should be the same type from the same source of supply or manufacture as the cement proposed for use in the field. Unless otherwise specified or approved, the cement should be Type GP or GB complying with the requirements of AS3972 - Portland and Blended Cements.
2. Cement should be stored in sealed containers and protected from moisture until used. Cement should not be used for laboratory investigations after being stored for a period of three months or longer.
3. The above test procedure may be used for materials stabilised in the field provided the samples are at close to optimum moisture content and the moulding of specimen can be completed within 75min of initial mixing. Samples should be placed in airtight containers and transported to the laboratory immediately. In this case procedures 3(f) and 4(a) are not applicable.



## UNCONFINED COMPRESSIVE STRENGTH OF UNSTABILISED MATERIALS AND MATERIALS STABILISED OR MODIFIED WITH CEMENT, LIME OR BITUMEN

### 1. SCOPE

This test method sets out the procedure for the preparation, curing and determination of unconfined compressive strength of remoulded specimens of soil, gravel or crushed rock material. The procedure may also be used with materials modified or stabilised in the field as well as with materials modified at the quarry.

This method is applicable to materials passing a 19.0 mm AS sieve.

The procedures have been adapted from NSW RTA Test Method T131.

### 2. APPARATUS

- (a) A cylindrical metal mould having an internal diameter of  $105 \pm 0.5$  mm and an internal effective height of  $115 \pm 1$  mm (a volume of approximately 1 litre), fitted with a detachable base-plate and a removable collar assembly approximately 60 mm high, both of which can be firmly attached to the mould. A suitable design is shown in AS 1289.5.2.1.
- (b)
  - (i) A metal rammer with a  $50 \pm 0.5$  mm diameter face and a drop mass of 2.7 kg + 10g - 25g, equipped with a suitable device to control the height of drop to a free fall of  $300 \pm 2$  mm, *or*
  - (ii) A metal rammer with a  $50 \pm 0.5$  mm diameter face and a drop mass of 4.9 kg + 10g, - 30g, equipped with a suitable device to control the height of drop to a free fall of  $450 \pm 2$  mm.

Suitable forms of hand apparatus are shown in AS 1289.5.2.1. Mechanical forms of the apparatus may be used provided the essential dimensions are adhered to.

- (c) A rigid foundation on which to compact the specimen, e.g., a sound concrete floor about 100mm or greater in thickness, or a concrete block of at least 100kg mass.
- (d) A metal mixing and quartering tray.
- (e) Mixing apparatus such as a trowel and palette knife and quartering apparatus, such as metal plates about 400 mm by 125 mm and 200 mm by 125 mm.
- (f) Sample dividers (riffle boxes) of appropriate size openings. (Optional).
- (g) A thermostatically controlled oven with good air circulation, capable of maintaining a temperature within the range of  $105^{\circ}\text{C}$  to  $110^{\circ}\text{C}$ .
- (h) 37.5 mm, 19.0 mm and 4.75 mm AS sieves.
- (i) A balance of at least 6000 g capacity, accurate and readable to 1 g within the operating range.
- (j) A balance of at least 500 g capacity, accurate and readable to 0.01 g within the operating range.
- (k) A jack, lever and frame, or other device, suitable for extruding compacted specimens from the mould.
- (l) A bowl suitable for thoroughly mixing increments of water with the test sample. A mixing machine may be used.



Road Projects Division

TEST METHOD : NTTM 203.1

REVISED DATE : 06/03

SHEET : 2 OF 6

- (m) Moisture measurement containers, at least 500 mL capacity, with press-on lids or other suitable seal.
- (n) A measuring cylinder, 100 mL.
- (o) A steel straightedge; about 300mm long, 25mm wide and 3mm thick, preferably with a bevelled edge.
- (p) A 300mm rule.
- (q) A porcelain mortar, approximately 180mm diameter, and a rubber pestle.
- (r) Metal dishes, approx. 225mm and 350mm diameter.
- (s) A humidity cabinet capable of maintaining a humidity of not less than 90 per cent at a temperature within the range of 21°C to 25°C. Alternatively, a water bath equipped with a snug-fitting lid and perforated metal false bottom with supports to provide a 50mm space below the perforated plate.
- (t) Materials and equipment for measuring and capping cylindrical test specimens, such as callipers, engineers tri-square, plate glass about 125 mm by 125 mm, a spirit level approximately 100 mm long, plaster of paris or orthopaedic plaster, small trowel or palette knife, mixing dish, etc.
- (u) A compression testing machine of at least 60 kN capacity complying, as regards accuracy, with the requirements of AS 2193 (Methods for the Calibration of Testing Machines) for Grade C machines. The upper bearing block of the machine shall have a spherical seat.

**3. PREPARATION OF SAMPLE**

- (a) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample were screened on a 4.75mm AS sieve only discrete, uncrushed particles would be retained. A rubber pestle should be used to avoid breaking down sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with a rubber pestle.
- (b) Weigh the sample to be tested and screen the sample on a 37.5mm and 19mm AS sieve. Weigh, then discard material retained. Calculate percentage retained on each of the two sieves.
- (c) Thoroughly mix all material in the portion passing the 19.0 mm AS sieve, and obtain by quartering or riffing a portion of no less than 6000g of material for preparation of a pair of test specimens.
- (d) Where the moisture content of the material is judged to be well below optimum, overnight curing may be required after initial addition of water. This curing should be carried out before the addition of the stabilising agent.

**4. PREPARATION OF ADDITIVES**

**4.1 Lime**

Lime used in laboratory investigations should be the same type from the same source of supply or manufacture as the lime proposed for use in the field. Unless otherwise specified or approved, quicklime and hydrated lime shall comply with Australian Standard 1672.1 – Limes and Limestone: Limes for Building.

- (a) Hydrated Lime is the most common form of lime used in lime stabilisation of road materials. It is usually supplied in the form of a fine, white power and consists essentially of calcium hydroxide. No preparation is required.



Road Projects Division

TEST METHOD : NTTM 203.1

REVISED DATE : 06/03

SHEET : 3 OF 6

- (b) Quicklime is supplied as ground quicklime, crushed or pebble quicklime, and consists essentially of calcium oxide. Unless supplied in ground form, the material should be ground to pass a 2.36mm AS sieve and stored in an air-tight container and protected from moisture until used.  
**See Note 1 for safety precautions related to the use of quicklime.**
- (c) Hydrated lime – pozzolan mixtures are prepared by mixing the dry materials in the desired proportions by mass and storing the mixture in an air-tight container protected from moisture until used.
- (d) Determine if directed, the available lime expressed as calcium oxide and calcium hydroxide, as described in Test Method NTTM 204.6 for the lime used in the laboratory testing.

#### 4.2 Cement

Cement used in laboratory investigations should be the same type from the same source of supply or manufacture as the cement proposed for use in the field.

Cements must be stored in sealed containers and protected from moisture until used. Cement should not be used for laboratory investigations after being stored for a period exceeding three months.

#### 5. PREPARATION AND CURING OF TEST CYLINDERS

- (a) Obtain, by quartering or riffing, two portions, each of about 3000g mass, from the sample prepared in 3(c) above.
- (b) Take one of the 3000g portions. Determine its moisture content using a minimum 300g sample in accordance with AS1289.2.1.1.
- (c) Determine the dry mass of the remainder of the 3000g portion to the nearest 1g.
- (d) Clauses (e), (f) and (h) do not apply when testing unstabilised materials.
- (e) Calculate the required amount of the prescribed additive, as a percentage of the calculated dry mass of the test portion, to the nearest 1g. Weigh out this quantity of additive.
- (f) Add the calculated amount of prescribed additive to the test portion, thoroughly mixing the materials to a uniform colour.

Where the prescribed additive is quicklime, add a quantity of water equal to about two thirds of the mass of the quicklime added to the material. Carefully mix as necessary, observing the safety precautions set out in Note 1 of this test method. Slaking will occur rapidly with generation of heat. The magnitude of the reaction will depend on the amount of quicklime present. Cover the mixture and allow to stand for 10-15 minutes. Re-mix to break any lumps that may have formed.

- (g) Add sufficient water to provide optimum moisture content, appropriate for the intended compactive effort, for the particular material and quantity of additive, if any, based on the dry mass of soil. Thoroughly mix.
- (h) Curing prior to compaction.
  - i. **Cement Modified;** Materials should be compacted as soon as practicable after the addition of cement and not later than 60-75min from mixing.
  - ii. **Bitumen Modified;** Materials should be compacted as soon as practicable after the addition of the bituminous material.
  - iii. **Lime Modified;** Materials should be placed in sealed container and allowed to cure overnight at room temperature.



Road Projects Division

---

TEST METHOD : NTTM 203.1

REVISED DATE : 06/03

SHEET : 4 OF 6

- (i) Weigh the mould and record the mass ( $M_2$ ) to the nearest 5g. Assemble the mould, collar and base plate and place the assembly on the rigid foundation. The interior of the mould should be oiled with a light application of oil. Wipe off any excess oil.
- (j) Compact the mixture into the mould by the specified compactive effort.
  - i. **Standard Compaction;** Compact the mixture into the mould in three approximately equal layers not varying in compacted thickness by more than 5mm. Subject each layer to 25 uniformly distributed blows of a 2.7kg rammer falling freely from a height of 300mm, *or*
  - ii. **Modified Compaction;** Compact the mixture into the mould in five approximately equal layers not varying in compacted thickness by more than 5mm. Subject each layer to 25 uniformly distributed blows of a 4.9kg rammer falling freely from a height of 450mm.
- (k) Use only sufficient material to slightly overfill the mould, leaving not more than 5mm to be struck off after removing the collar.
- (l) With a quantity of not less than 300 g from the excess mixed and moistened material, check the moisture content as set out in Clause 5 (b).
- (m) Free the material from around the collar of the mould assembly and then carefully remove the collar.
- (n) Level the compacted specimen to the top of the mould by means of the straightedge. Patch with smaller sized material any holes developed in the surface by removal of coarse material. Make up a slurry of some of the excess material and trowel the slurry on the top surface of the specimen to provide a smooth, level surface, taking care to ensure that the surface is plane within 0.1 mm to avoid the need for capping.
- (o) Remove the base-plate and weigh the mould plus compacted specimen and record the mass ( $M_1$ ) to the nearest 1g.
- (p) Carefully eject the compacted specimen from the mould. Stand the compacted specimen on a filter paper in a dish and place in a humidity cabinet or suitable water bath.
- (q) Repeat processes 5 (b) to 5 (p) with the other 3000g portion to provide a duplicate specimen.
- (r) Cure the specimens as specified, e.g. 7 days or 28 days.
- (s) On completion of the period of curing, immerse each test specimen in water at room temperature for 4 hours. The specimen should be covered by at least 10mm of water so that entrapped air may escape. Allow to drain for 15 minutes.

**6. CAPPING OF TEST SPECIMENS**

- (a) Examine the condition of the surfaces of the test specimen. If cracking has occurred, at the junction of layers, the specimen should be discarded. Cap the ends of cylinders which are:
  - i. More than 2° out of square from the axis; *and/or*
  - ii. Which have small depressions or other irregularities that would cause the load to be applied over 90% or less of the surface area.
- (b) Cap the test specimen if required, with a thin layer of plaster, preferably orthopaedic plaster.
- (c) Allow the test specimen to stand at constant moisture content for one hour and then subject to the compression test.



Road Projects Division

TEST METHOD : NTTM 203.1

REVISED DATE : 06/03

SHEET : 5 OF 6

7. COMPRESSION TESTING

- (a) Determine the average diameter ( $D_m$ ) of the test specimen to the nearest 0.5mm from two diameters measured at right angles to each other near the centre of the height of the cylinder.
- (b) Place the test specimen on the lower bearing block of the compression testing machine, making sure that the vertical axis of the test specimen is aligned with the centre of thrust of the upper bearing block. Bring the upper bearing block to bear on the test specimen and ensure that uniform seating is obtained.
- (c) Apply the load continuously at a uniform rate of  $0.10 \pm 0.02$  MPa per second. Record the load at failure of the test specimen to the nearest 0.5 kN.

8. CALCULATIONS

- (a) Calculate the mass of the test specimen as compacted ( $M_3$ ), as follows:-

$$M_3 = (M_1 - M_2)g$$

- (b) Calculate the moisture content ( $w$ ) of the test specimen as compacted, as follows:-

$$w = \frac{A - B}{B - C} \times 100$$

Where  $w$  = percentage of moisture in test specimen,

A = mass of moisture tin + wet sample,

B = mass of moisture tin + oven-dry sample,

C = mass of moisture tin.

- (c) Calculate the dry density of the test specimen as compacted, as follows:-

$$\text{Dry Density} = \frac{M_3 \times 0.1}{100 + w} \text{ t/m}^3$$

- (d) Calculate the unconfined compressive strength of the test specimen as follows:-

$$\text{UCS(MPa)} = \frac{\text{Load (kN)} \times 1000}{\text{Area(mm}^2)} = \frac{\text{Load (kN)} \times 1273}{(D_m)^2}$$

Where  $D_m$  = average diameter in mm.



Road Projects Division

TEST METHOD : NTTM 203.1

REVISED DATE : 06/03

SHEET : 6 OF 6

9. REPORTING

Report the following data for each pair of test specimens as appropriate: -

- (a) Type and source of additive.
- (b) Additive content.
- (c) Moisture content at which specimens were compacted.
- (d) Compactive effort applied.
- (e) Dry density of test specimens as compacted in  $t/m^3$  to the nearest  $0.01 t/m^3$ .
- (f) Period and conditions of curing.
- (g) Period of soaking.
- (h) Condition of specimens, i.e. moist or dry after curing.
- (i) Unconfined compressive strength, as the average of the strengths of duplicate test specimens, in MPa to the nearest 0.05 MPa.
- (j) Percentage of materials retained on 37.5mm and 19mm AS sieves.

10. TECHNIQUES

The height of each layer should be checked with a gauge or rule to ensure that the layer is about one-third (or one-fifth) of the height of the mould. If the final layer is more than 5 mm above the top of the mould after removing the collar, the specimen should be rejected.

Slightly scarify the top surface of the first and second layers, before adding the next layer, to ensure adequate bonding between layers.

11. NOTES ON TEST

- 1. **Quicklime may be dangerous in the presence of moisture because of its highly caustic nature. Even small amounts of perspiration on the skin may react with quicklime and cause skin burns. Quicklime is especially dangerous to the eyes. Safety glasses, long sleeved coats and gloves should be worn, and protective cream applied to the hands and arms as required, when using quicklime in the laboratory.**
- 2. Hydrated lime is relatively safe, but care is required to protect the eyes when using hydrated lime.
- 3. The coarser particles of quicklime may hydrate slowly after compaction. In some cases, the resulting volume increase will cause compacted specimens to disintegrate. Potential problems associated with volume increase on hydration are best highlighted during laboratory testing, stressing the importance of using the same additive (of the same grading) as will be used in the field.
- 4. The exclusion of a large proportion of stone coarser than 19.0mm may have a major effect on the unconfined compressive strength determined, compared with that obtainable with the material as a whole.
- 5. The chemical reactions producing cementitious compounds only take place in the presence of moisture. Strength development ceases when the material dries out. It is therefore essential that the specimens are kept moist during the curing phase. Results from specimens which have dried out during the curing phase should be treated with considerable caution.



## CEMENT CONTENT OF STABILISED MATERIALS - HEAT OF NEUTRALISATION METHOD

### 1. SCOPE

This method describes a procedure for the quick determination of the cement content of fresh mixtures of gravel or fine crushed rock and cement. This method is not appropriate for limestone. It is based on the measurement of the heat of neutralisation of the cement. After preparation of a calibration curve, results may be obtained within ten minutes of sampling.

This procedure is adapted from NSW RTA Test Method T137.

### 2. APPARATUS

- i. Shovel
  - ii. Sample splitter, having 50mm slots
  - iii. Scoop
  - iv. Plastic jar, with approximately 4.5 litres capacity and 10cm opening, and a screw-on water tight lid.
  - v. Large plastic container, of approximately 20 litre capacity for buffer solution.
  - vi. Measuring cylinder, of 1.5 litre capacity.
  - vii. Thermometer – 0 - 50°C readable to 0.2°C.
  - viii. Balance, of at least 6000g capacity and accurate and readable to at least 10g.
  - ix. Beakers;
    - 1 x 250ml capacity for weighing cement \*
    - 1 x 500ml capacity for weighing water \*
    - 1 x 5 litre capacity for mixing buffer \*
- \* Only necessary for calibration

### 3. REAGENTS

- (a) Anhydrous sodium acetate ( $\text{CH}_3\text{COONa}$ ) (Technical grade)
- (b) Glacial acetic acid ( $\text{CH}_3\text{COOH}$ ) (Technical grade)

### 4. MATERIALS

- (a) A representative sample of at least 40kg of the fine crushed rock/gravel to be used.
- (b) A sample of about 1.5kg of the cement to be used.

### 5. REQUIRED INFORMATION

- (a) The moisture content to be used in the material for the job i.e. percent mass per mass of dry crushed rock/gravel.
- (b) The job target cement content to be used in the material for the job i.e. percent mass per mass of dry crushed rock/gravel.

### 6. PREPARATION OF BUFFER SOLUTION

One litre of buffer solution shall be prepared for each test and for each point on the calibration curve.

- i. For each litre of buffer solution, 250g of sodium acetate, 240g of glacial acetic acid, and about 500ml of potable water shall be mixed until all solids have dissolved.
- ii. The solution shall then be made up to 1000ml with potable water.



Road Projects Division

TEST METHOD : NTTM 204.1

REVISED DATE : 06/03

SHEET : 2 OF 3

7. PREPARATION OF CALIBRATION CURVE

Six percentages of cement contents shall be chosen around the job target cement content. For example, if the target figure is 2% cement, then percentages of 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 shall be used.

For each of these percentages the following procedure shall be carried out:

- i. The mass of crushed rock/gravel, cement and water shall be calculated so that the total mass is 5000g (see Note 1). Start with the highest percentage of cement required for calibration (see Note 2).
- ii. The calculated mass of crushed rock shall be weighed into the plastic jar, and the cement and water weighed into separate beakers.
- iii. The cement shall be added to the crushed rock and the mix shaken.
- iv. The water shall then be added and the mix shaken for exactly 2 minutes.
- v. The thermometer shall be pushed carefully into the mixture and the temperature (A)°C shall be read after 60 seconds.
- vi. The measuring cylinder shall be filled to the 1000ml mark with the buffer solution, (see Note 2).
- vii. The thermometer shall be placed in the solution and the temperature (B)°C shall be read after 60 seconds.
- viii. The buffer shall be poured into the mix in the plastic jar and the mixture shaken for exactly 4 minutes.
- ix. The thermometer shall be pushed carefully into the mixture and the temperature (C)°C shall be read after 60 seconds.
- x. The temperature rise (DT) shall be calculated using the following equation:-

$$DT = C - \frac{A + B}{2}$$

where DT = Temperature Rise °C

A = Initial temperature of mix °C

B = Initial temperature of buffer °C

C = Final temperature of buffer and mix °C

- xi. Temperature rise (DT) shall be plotted against the cement content (percent by mass of dry crushed rock/gravel).

8. TEST PROCEDURE

- (a) A sample of the mix shall be obtained as soon as possible after mixing.
- (b) For example, a shovel may be held under the pugmill where the mix pours into the truck or storage hopper. The quantity of sample should be approximately 20kg. The sample shall be split through the sample splitter until a 5kg sample is obtained.
- (c) The subsample of 5kg shall be weighed into the plastic jar, and the temperature (A)°C recorded after 60 seconds.
- (d) The measuring cylinder shall be filled to the 1000ml mark with buffer solution, and the temperature (B)°C recorded after 60 seconds.
- (e) The buffer shall be added to the mix in the plastic jar, and the mixture shaken for exactly 4 minutes.
- (f) The thermometer shall be carefully pushed into the mix and the temperature (C)°C recorded after 60 seconds.
- (g) The temperature rise (DT) shall be calculated as in section 7 (x).



## 9. REPORTING

The cement content corresponding to the temperature rise shall be read from the calibration graph and reported as a percentage, by mass of dry crushed rock/gravel, to the nearest 0.1%.

### NOTES:

1. Example of calculation of mass of crushed rock/gravel, cement and water.

For Cement Content 2% and Moisture Content 8%.

Let mass of crushed rock/gravel = x g

$$\text{then mass of water} = \frac{8x}{100g} = 0.08xg$$

$$\text{and mass of cement} = \frac{2x}{100g} = 0.02xg$$

$$\text{Total mass} = x_g + 0.08x_g + 0.02x_g = 1.10x_g$$

$$\text{Therefore } 1.10x_g = 5000g$$

$$\text{Therefore mass of crushed rock/gravel } x = \frac{5000}{1.1g} = 4545.5g$$

$$\text{and mass of water} = 0.08x_g = 0.08 \times 4545.5 = 363.6g$$

$$\text{and mass of cement} = 0.02x_g = 0.02 \times 4545.5 = 90.9g$$

2. For high percentages of cement (about 3.5% and above), the rock/gravel, cement and buffer mixture may gel into a solid mass, thus preventing proper mixing. If percentages above 3.5 are expected, then 1500ml of buffer solution should be used instead of 1000ml, for all calibration points and tests.



## DETERMINATION OF THE LIME SATURATION POINT OF STABILISED MATERIALS - pH METHOD

### 1. SCOPE

This test method sets out the procedure for the determination of the approximate percentage of hydrated lime required to saturate a soil or gravel. This information may be applied in the determination of suitable additive contents in soil modification and stabilisation investigations.

This test method is adapted from NSW RTA Method T144.

### 2. APPARATUS

- (a) 19.0mm, 9.50mm and 4.75mm A.S. sieves.
- (b) A balance of at least 1kg capacity accurate and readable to 0.1g within the operating range.
- (c) A balance of at least 500g capacity accurate and readable to 0.01g within the operating range.
- (d) Metal dishes, approximately 100mm, 225mm and 350mm diameter.
- (e) A mixing and quartering tray.
- (f) Mixing apparatus such as a trowel, spatula, and quartering apparatus such as metal plates 400mm by 125mm and 200mm by 25mm.
- (g) Sieve brushes.
- (h) A porcelain mortar, 178mm diameter with porcelain and rubber pestles.
- (i) Sample dividers (riffle boxes) with appropriate size openings (optional).
- (j) A thermostatically controlled oven with good air circulation, capable of maintaining a temperature not exceeding 50°C.
- (k) Desiccator, preferable cabinet type.
- (l) A pH meter with a scale accurate and readable to 0.1 pH unit complete with alkaline-type electrodes.
- (m) Beakers 250ml.
- (n) Rubber-tipped glass stirring rods.

### 3. REAGENTS

- (a) A quantity of fresh hydrated lime.
- (b) Freshly boiled distilled or de-ionised water.

### 4. PREPARATION OF THE SAMPLE

- (a) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample in an oven at a temperature not exceeding 50°C.
- (b) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample were screened on a 2.36mm A.S. sieve, only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking down sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with a rubber pestle.
- (c) Reduce the sample, as necessary, by quartering or riffing, to provide an amount sufficient to yield not less than 500g of material passing a 4.75mm A.S. sieve.
- (d) Screen the sample on a 4.75mm A.S. sieve. To facilitate this operation and to avoid overloading of sieves, screen the sample on a 19.0mm and 9.50mm A.S. sieve prior to separation on a 4.75mm A.S. sieve.



Road Projects Division

TEST METHOD : NTTM 204.5

REVISED DATE : 06/03

SHEET : 2 OF 2

5. PROCEDURE

- (a) Determine the available lime content of the lime to be used in the laboratory investigation, in accordance with the procedure described in Test Method: NTTM 204.6.
- (b) Quarter the sample of soil obtained in 4 (c) above to yield eight sub-samples of approximately 50g each.
- (c) Weigh each sub-sample and record its mass.
- (d) Place one sub-sample in a 250ml beaker.
- (e) Add a quantity of hydrated lime to each of the other sub-samples so that the proportion of hydrated lime varies from sub-sample to sub-sample by 1% by mass.
- (f) Thoroughly mix the lime into the soil in each of the sub-samples and transfer the soil-lime mixtures to 250ml beakers.
- (g) Add 100ml freshly boiled distilled or de-ionised water to each beaker, including that containing soil only.
- (h) Stir each beaker of material vigorously for 1 minute. Ensure that all of the material in each beaker is uniformly mixed (ie. all the material has been wetted).
- (i) After 10 minutes remix each beaker for a further one minute and repeat this procedure six times.
- (j) Place 4 g of hydrated lime in a 250ml beaker and add 100ml freshly boiled distilled or de-ionised water and mix vigorously for two minutes. Remix as in (i) above keeping the beaker covered between mixes.
- (k) Using the manufacturer's instructions for the particular pH meter being used, determine the pH of the soil-water mixtures after completion of the last mixing in (i) and (j) above.
- (l) If the pH of the sub-sample with the highest percentage of added lime does not equal the pH of the lime-water mixture, make up a further mixture of soil plus lime, varying the lime content so that the final pH is at least equal to that of the lime-water mix.
- (m) Prepare a graph of pH versus percentage by mass of lime added to the soil. Draw in the line of pH corresponding to the pH of the water-lime mix.

6. CALCULATIONS

- (a) Determine from the graph the percentage of lime ( $L_1$ ) required to saturate the sample. This is the point of intersection of the pH versus added lime graph and the line of pH of the water-lime mix.
- (b) Calculate the percentage of material (P) passing the 4.75mm sieve.
- (c) Calculate the percentage of lime ( $L_2$ ) needed to saturate the whole soil as follows:-

$$L_2 = \frac{L_1 \times P}{100}$$

**NOTE:** This then represents the mid-point of the range of lime percentages to be used in stabilisation investigations.

7. REPORTING

- (a) Report the available lime content (expressed as calcium hydroxide) of the lime used in the laboratory investigation.
- (b) Report to the nearest 0.5% the percentage of lime, by mass, needed to saturate the whole soil.

8. TECHNIQUE

In cases where the pH of the lime-soil mixes will not attain the pH of the water-lime mix, take  $L_1$  to be equal to the percentage of lime where the graph of pH versus lime-content reaches a plateau.



## AVAILABLE CALCIUM OXIDE OR CALCIUM HYDROXIDE IN LIME

### 1. SCOPE

This test method sets out the procedure for determining the available calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ) or calcium oxide ( $\text{CaO}$ ) in hydrated lime or quicklime respectively.

The method is adapted from NSW RTA Test Method T430.

### 2. APPARATUS

- (a) Laboratory glassware including pipettes, burettes, volumetric flasks, etc.
- (b) A balance of suitable capacity with a limit of performance of 0.005g.
- (c) 300 $\mu\text{m}$  AS sieve.
- (d) Hot Plate.

### 3. REAGENTS

- (a) Sucrose Solution

Dissolve 100g sucrose in 200mL of  $\text{CO}_2$  - free distilled water. Add several drops of phenolphthalein indicator solution. Titrate with 0.1 M NaOH solution dropwise while stirring until a faint pink colour persists. This solution should not be kept for more than 2 days.

- (b) Sodium Hydroxide Solution (0.1M). Dissolve 0.4g NaOH in water and dilute to 100 mL.

**CAUTION: Sodium Hydroxide is very alkaline and corrosive and can cause severe burns. Avoid contact with skin, eyes and clothing. If the solution is spilt, wash off immediately with water. Safety glasses must be worn.**

- (c) Indicator: (4 per cent phenolphthalein).

Dissolve 4g of dry phenolphthalein in 100mL of 95% ethanol.

- (d) Hydrochloric Acid Solution (0.5M). Dilute 50mL of concentrated AR hydrochloric acid with water to 1000mL in a volumetric flask. Standardise against sodium carbonate or borax (an example of a procedure is given in Vogel - "Quantitative Inorganic Analysis")

**CAUTION: Hydrochloric acid is corrosive, handle with care. Always add acid to water, NEVER the reverse. Safety glasses must be worn.**

### 4. SAMPLE PREPARATION

In the case of quicklime, take a representative sample and crush as rapidly as possible to a size passing a 300  $\mu\text{m}$  AS sieve and place in a sealed container until required for testing. Testing should be carried out as soon as possible.

**CAUTION: Quicklime is very corrosive in contact with moisture. Avoid breathing the dust when crushing and sieving by wearing a face mask.**



Road Projects Division

TEST METHOD : NTTM 204.6

REVISED DATE : 06/03

SHEET : 2 OF 3

5. PROCEDURE

- (a) Accurately weigh about 0.5g of the sample passing 300µm AS sieve and carefully add to a 250mL Erlenmeyer flask containing 10mL of cold CO<sub>2</sub> - free distilled water and immediately stopper the flask. When testing hydrated lime, proceed to Procedure (d).
- (b) Place the flask on a hot plate, remove the stopper and immediately add 50mL of boiling CO<sub>2</sub> - free distilled water to the flask. Swirl the flask and boil actively for 1 minute for complete slaking.
- (c) Remove from the hot plate, stopper the flask loosely, and place in a cold water bath to cool to room temperature.
- (d) Add 60mL of sucrose solution. Stopper the flask, swirl and let stand for 10 to 20 minutes, swirling at 5 minute intervals.
- (e) Remove stopper, add 4 to 5 drops of indicator and titrate rapidly (in the original flask) with the hydrochloric acid solution. When the first complete disappearance of the pink colour is noted, read the end point.
- (f) Repeat Procedure (a) to (e) with a second sub-sample of lime.

6. CALCULATIONS

- (a) As calcium hydroxide

$$\text{Percent of lime} = 0.037 \times T \times \frac{M}{w} \times 100$$

- (b) As calcium oxide

$$\text{Percent of lime} = 0.028 \times T \times \frac{M}{w} \times 100$$

Where T = volume of acid used to titrate the sample (mL).  
M = molarity of the acid used.  
W = mass of sample (g).

- (c) Calculate the available calcium oxide or calcium hydroxide to the first decimal place and take the mean of the two determinations.

7. REPORTING

Report the following:

- (a) Type of lime tested.
- (b) Source of lime.
- (c) For quicklime, available lime expressed as calcium oxide rounded off to the nearest whole number. Values of 0.5 are to be rounded up.
- (d) Or for hydrated lime, available lime expressed as calcium hydroxide rounded off to the nearest whole number. Values of 0.5 are to be rounded up.



Road Projects Division

---

TEST METHOD : NTTM 204.6

REVISED DATE : 06/03

SHEET : 3 OF 3

**8. ALTERNATIVE PROCEDURE**

- (a) 0.25 M oxalic acid may be used as an alternative to 0.5 M hydrochloric acid when a standard solution is not available. Make up the 0.25M oxalic acid solution by dissolving 31.5g  $H_2C_2O_4 \cdot 2H_2O$  in 1 litre of distilled water. This solution need not be standardised.

**CAUTION: Oxalic acid is very poisonous by ingestion. Avoid contact with skin and as a precaution wash hands after handling.**

In this case the calculations are:

- (i) As calcium hydroxide

$$\text{Percent of lime} = 0.074 \times T \times \frac{M}{w} \times 100$$

- (ii) As calcium oxide

$$\text{Percent of lime} = 0.056 \times T \times \frac{M}{w} \times 100$$

Where T = volume of acid used to titrate the sample (mL).  
M = molarity of the acid used.  
W = mass of sample (g).



## RATE OF SPREAD OF LIME OR CEMENT

### 1. SCOPE

This test method sets out the procedure for determining the rate of spread of lime or cement used in soil modification or stabilisation. This procedure is only applicable where the lime or cement is spread by means of a mechanical spreader.

This test method is adapted from NSW RTA Test Method T136.

### 2. APPARATUS

- (a) A balance of 10kg capacity, accurate and readable to 1g within the operating range.
- (b) Galvanised iron trays, as required, with internal measurements 1,000mm x 300mm with sides approximately 40mm high.

### 3. PROCEDURE

- (a) Place the metal tray on the pavement to be modified or stabilised with its long side parallel to the edge of the pavement. Ensure that the wheels of the mechanical spreader will not touch the tray.
- (b) Remove the tray immediately after the spreader has passed over the tray and record the mass of the lime or cement retained in the tray to the nearest 1g.

### 4. CALCULATION

- (a) Calculate rate of spread of lime or cement (R), as follows:-

$$R = \frac{M}{300} \text{ kg/m}^2$$

where M = mass (in grams) of material retained on tray.

### 5. REPORTING

Report the rate of spread of lime or cement to the nearest 0.01kg/m<sup>2</sup>.



## **STABILISER DISTRIBUTION**

### **1. SCOPE**

This method describes the procedure for the determination of the vertical and/or horizontal distribution of stabiliser content for the full thickness of pavement layers.

### **2. PREPARATION**

- (a) Determine the thickness of the pavement in accordance with NTTM 216.1.
- (b) Select test sites as necessary in accordance with NTCP 103.1.
- (c) At each test site, select three evenly spaced test locations across the run.
- (d) At each test location divide the thickness of the layer into 2. (Top half and bottom half), for vertical distribution of stabiliser.

### **3. PROCEDURE**

Determine the Stabiliser Content of both the top half and the bottom half of the layer, in accordance with the relevant Northern Territory Test Methods or Australian Standards.

### **4. REPORT**

Report the following for each test location:

- (a) Location
- (b) Layer thickness
- (c) Stabiliser Content of top half.
- (d) Stabiliser Content of bottom half.



Road Projects Division

TEST METHOD : NTTM 205.1

REVISED DATE : 06/03

SHEET : 1 OF 4

**DURABILITY - CEMENT STABILISED MATERIALS**

**1. SCOPE**

This test method sets out the procedure for the determination of the durability of soil, gravel or crushed rock material modified or stabilised in the laboratory by the addition of cement using modified compaction.

This test method is adapted from NSW RTA Method T133.

**2. APPARATUS**

- (a) As described in AS1289.5.2.1.
- (b) A humidity cabinet capable of maintaining a humidity of not less than 90 per cent at a temperature within the range of 21°C to 25°C. Alternatively, a water bath equipped with a snug fitting lid and perforated metal false bottom with supports to provide a 50mm space below the perforated plate.
- (c) Water bath.
- (d) Steel bristle wire brush with 30mm minimum length bristles.

**3. PREPARATION OF SAMPLE**

- (a) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample at a temperature not exceeding 50°C.
- (b) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations of particles are to be broken down so that if the sample was screened on a 4.75mm AS sieve, only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking down sound pieces of mineral matter. Adhering material should be brushed from coarse pieces. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with a rubber pestle.
- (c) Screen the sample on a 19.0mm AS sieve. Discard material retained.
- (d) Thoroughly mix all material passing the 19.0mm AS sieve, and reduce, as necessary, by quartering or riffing, to provide not less than 5000g of material for each cement content.

**4. CEMENT**

- (a) Cement used in laboratory investigations should be the same type from the same source of supply or manufacture as the cement proposed for use in the field.
- (b) Cement should be stored in sealed containers and protected from moisture until used. Cement should not be used for laboratory investigations after being stored for a period of three months or longer.

**5. PROCEDURE**

- (a) Obtain, by quartering or riffing, two 2500 g portions, of the sample prepared in 3(d) above.
- (b) Weigh the mould and record the mass ( $M_2$ ) to the nearest 5g.
- (c) Assemble the mould, collar and base-plate and place the assembly on the rigid foundation.
- (d) Take one of the 2500g portions and determine the mass to the nearest 1g. Screen on a 4.75mm A.S. sieve. All material retained on the 4.75mm A.S. sieve shall be soaked for at least one hour and then surface dried.



Road Projects Division

---

TEST METHOD : NTTM 205.1

REVISED DATE : 06/03

SHEET : 2 OF 4

- (e) Add the required amount of cement, calculated as a percentage of the dry mass of the sample determined in 5 (d), to the material passing the 4.75mm A.S. sieve and thoroughly mix the dry materials to a uniform colour. Add a small quantity of water (approximately 5 per cent by mass for sandy or gravelly materials and 8 per cent for clayey materials) and mix. Incorporate the saturated surface dry material retained on the 4.75mm A.S. sieve and remix. Add water to bring the sample to its optimum moisture content. Cover the mixture and allow to stand for not less than 5 minutes but not more than 10 minutes. Thoroughly remix the material.
- (f) Compact the mixture into the mould at the optimum moisture content for the specified compactive effort.
- (g) Use only sufficient material to slightly overfill the mould leaving not more than 5mm to be struck off after removing the collar. Free the material from around the collar and then carefully remove the collar.
- (h) Level the compacted material to the top of the mould by means of the straightedge. Patch with smaller sized material any holes developed in the surface by removal of coarse material.
- (i) Remove the base-plate and weigh the mould plus compacted material and record the mass ( $M_1$ ) to the nearest 5g.
- (j) Carefully extrude the sample from the mould.
- (k) Cure the specimens for 7 days from the time of compaction at not less than 90 per cent humidity at a temperature within the range of 21°C to 25°C.
- (l) Repeat processes (b) to (j) for the other portion. One cylinder (SPECIMEN 1) shall be used in subsequent testing for volume and moisture content changes and the other cylinder (SPECIMEN 2) shall be used in subsequent testing for loss by abrasion.
- (m) Immerse the cylinders in a water bath at room temperature for 5 hours. On removal from the water the cylinders shall be weighed to nearest 5g and the height and diameter measured to the nearest 5mm to obtain the volume.
- (n) Place the cylinders in an oven at 65°C to 70°C for 42 hours.
- (o) Remove the cylinders from the oven.
- (p) Weigh SPECIMEN 1, measure the diameter and height and determine moisture content and volume changes.
- (q) Abrade SPECIMEN 2 with two firm strokes with a wire bristled brush on each part of the side and ends of the cylinder. The brush shall be applied to the full length and breadth of the specimen. Approximately 18 to 20 vertical strokes are necessary on the side and 2 are required on each end of the cylinder. Weigh the specimen after abrasion and compute the loss in mass as a percentage of the original mass.
- (r) Repeat the procedure set out in (m) to (o) for another 11 cycles.
- (s) On completion of the 12 cycles dry the cylinders to constant mass ( $M_4$ ) at 105°C to 110°C and determine the moisture content ( $w$ ) of each specimen.
- (t) Repeat the procedure for each of the specified cement contents.



Road Projects Division

TEST METHOD : NTTM 205.1

REVISED DATE : 06/03

SHEET : 3 OF 4

6. CALCULATIONS

- (a) Calculate the mass of compacted material (M) after compaction, as follows:-

$$M = (M_1 - M_2) g$$

- (b) Calculate the change in volume of SPECIMEN 1 (as a percentage by volume) as follows:-

$$V = \frac{1000 - V_{12}}{10}$$

Where V = volume change (per cent)

$V_{12}$  = volume of specimen after completion of 12 cycle of wetting and drying (cm<sup>3</sup>).

- (c) Calculate the change in mass of SPECIMEN 1 (as a percentage by mass) as follows:

$$M_c = \frac{M - M_{12}}{M} \times 100\%$$

Where  $M_c$  = change in mass (per cent)

M = mass of material after compaction (g)

$M_{12}$  = mass of material after 12 cycles of wetting and drying (g)

- (d) Calculate the loss in mass of SPECIMEN 2 (as a percentage by mass) after abrasion as follows:

$$M_A = \frac{M - M_{12}}{M} \times 100\%$$

Where  $M_A$  = loss of mass (per cent).

M = mass of material after compaction

$M_{12}$  = mass of material after 12 cycles of wetting and drying

- (e) Calculate the final moisture content of the specimens (as a percentage by mass) as follows:

$$w = \frac{M_{12} - M_4}{M_4} \times 100\%$$

Where w = moisture content

$M_{12}$  = mass after 12 cycles of wetting and drying (g)

$M_4$  = dry mass after 12 cycles of wetting and drying (g)

- (f) Calculate the change in moisture content of the specimens as follows:

$$W = \frac{w - O_{Mc}}{O_{Mc}} \times 100\%$$

Where W = change in moisture content (per cent).

w = final moisture content from (e)

$O_{Mc}$  = optimum moisture content as determined by Test Method NTTM 201.3.



## **7. REPORTING**

Report the following results for each cement content as appropriate:

- (a) Type and source of cement.
- (b) Cement content as a percentage by mass.
- (c) Compactive effort applied.
- (d) Optimum moisture content.
- (e) Change in volume after 12 cycles of wetting and drying.
- (f) Change in mass after 12 cycles of wetting and drying.
- (g) Change in mass after 12 cycles of wetting and drying and abrasion.
- (h) Change in moisture content.



**Road Projects Division**

---

TEST METHOD : NTTM 211.1

REVISED DATE : 06/03

SHEET : 1 OF 3

**PLATE BEARING TEST**

**1. SCOPE**

This method covers the estimating of the bearing value of soil in place by means of field loading tests. This test is only a part of the necessary procedure for soil investigation for foundation design. It gives information on the soil only to a depth equal to about two diameters of bearing plate, and takes into account only part of the effect of time.

**2. APPARATUS**

The apparatus shall include the following:

- (a) Loading Platforms or Bins, of sufficient size and strength to supply the estimated total load required, or equivalent means of supplying the total load reaction anticipated.
- (b) Hydraulic or Mechanical Jack Assembly of sufficient capacity to provide the maximum estimated load on the largest plate for the specific soil conditions involved, but not less than 50 tonnes in any case, and a device for measuring the force exerted by the jack. If a hydraulic jack is used without other force measuring device, it should be equipped with a pressure gauge capable of recording the jack load to an accuracy of  $\pm 2$  per-cent and should be recently calibrated with the jack to ensure an accuracy of  $\pm 2$  per-cent for the assembly. If a pressure-measuring device is to be interposed between the jack and the reaction, it should be capable of recording the load with an accuracy of at least  $\pm 2$  per-cent.
- (c) Bearing Plates. - Three circular steel bearing plates, not less than 25mm in thickness and varying in diameter from 200 - 750mm, including the minimum and maximum diameter specified.
- (d) Dial Gauges, or other settlement-recording devices, capable of measuring settlement of the test plates to an accuracy of at least 0.01mm.
- (e) Miscellaneous Apparatus, including columns, steel shims, and other construction tools and equipment required for preparation of the test pits and loading apparatus. (See Note 1)

**3. PREPARATION FOR TESTS**

- (a) Selection of Test Areas. - The selection of representative test areas to be based on the results of exploratory borings and on the design requirements of the structure.
- (b) Unless otherwise specified, the load test should be made at the elevation of the proposed footings and under the same conditions to which the proposed footings will be subjected, such as confined or unconfined footing, at the moisture conditions as found, or as may be altered by possible future wetting.
- (c) Test Pits. - At least three test locations shall be required, and the distance between test locations shall be not less than three times the diameter of the largest plate used in the tests. Prior to loading, test pits and areas should be protected against moisture changes in the soil unless it is expected that wetting of the soil will occur at some future time, as in the case of hydraulic structures. In this case, the soil in the area should be pre-wetted to the desired extent to a depth not less than twice the diameter of the largest bearing plate.
- (d) Loading Platforms. - The loading platforms or bins shall be supported by cribbing, or other suitable means, at points as far removed from the test area as practicable. The total load required for the test shall be in place before the test is started.



Road Projects Division

TEST METHOD : NTTM 211.1

REVISED DATE : 06/03

SHEET : 2 OF 3

- (e) Dead Load. - All equipment used, such as steel plates, loading column and jack, etc., that are to be placed on the test area prior to the application of load increments, shall be weighed and recorded as dead load.

**4. PROCEDURE**

- (a) Load Increments. - Apply the load to the soil in increments of not more than  $100\text{kN/m}^2$  or of not more than one-fifth of the estimated bearing capacity of the area being tested. Accurately measure each load,
- (b) and apply it in such a manner that all of the load reaches the soil as a static load, without impact, fluctuation, or eccentricity.
- (c) Time Interval of Loading - After the application of each load increment, maintain the cumulative load with no more than negligible variation for a selected time interval of not less than 1 hour. Other longer time intervals may be determined by maintaining the load until the settlement has ceased or the rate of settlement becomes uniform, but any time interval so selected shall be maintained for each load increment in all tests of any series.

**5. RECORD OF TESTS**

In addition to the continuous listing of all time, load and settlement data for each test, as prescribed in Section 4, a record shall also be made of all associated conditions and observations pertaining to the test, including the following:

- Date,
- List of Personnel,
- Weather conditions, and
- Irregularity in routine procedure

**NOTES ON TEST:**

1. Testing assemblies may vary widely, depending on job conditions, testing requirements, and equipment available. The testing assembly and program of testing should be planned in advance and approved by the supervising engineer, and, in general, can permit considerable latitude in details within the specific requirements noted above and outlined in the following test procedure.

A typical assembly for conducting load tests is illustrated in Fig. 1.

2. Measurement of Settlement. - Measure the settlement by dial gauges or other devices that will supply measurements accurate to 0.01mm and keep a continuous record of all settlements. Make settlement measurements as soon as possible before and after the application of each load increment, and at such equal time intervals, while the load is being held constant, as will provide not less than six settlement measurements between load applications. The reference beam supporting the dial gauges or other settlement - recording device shall be independently supported as far from load application as practicable, and preferably not less than 2.5m.
3. Termination of Tests. - Continue each test until the settlement has definitely become progressive and the rate of settlement or load has increased beyond the capacity of the testing apparatus. If sufficient load is available, the test should be continued until the total accumulated settlement is not less than 25mm. After completion of observations for the last load increment, release this applied load in steps and continue recording dial readings until there is no further elastic rebound for a period that is at least equal to the selected time interval. Other loading and unloading sequences may be adopted to suit the particular requirements of the project. These should be agreed before the commencement of the tests.

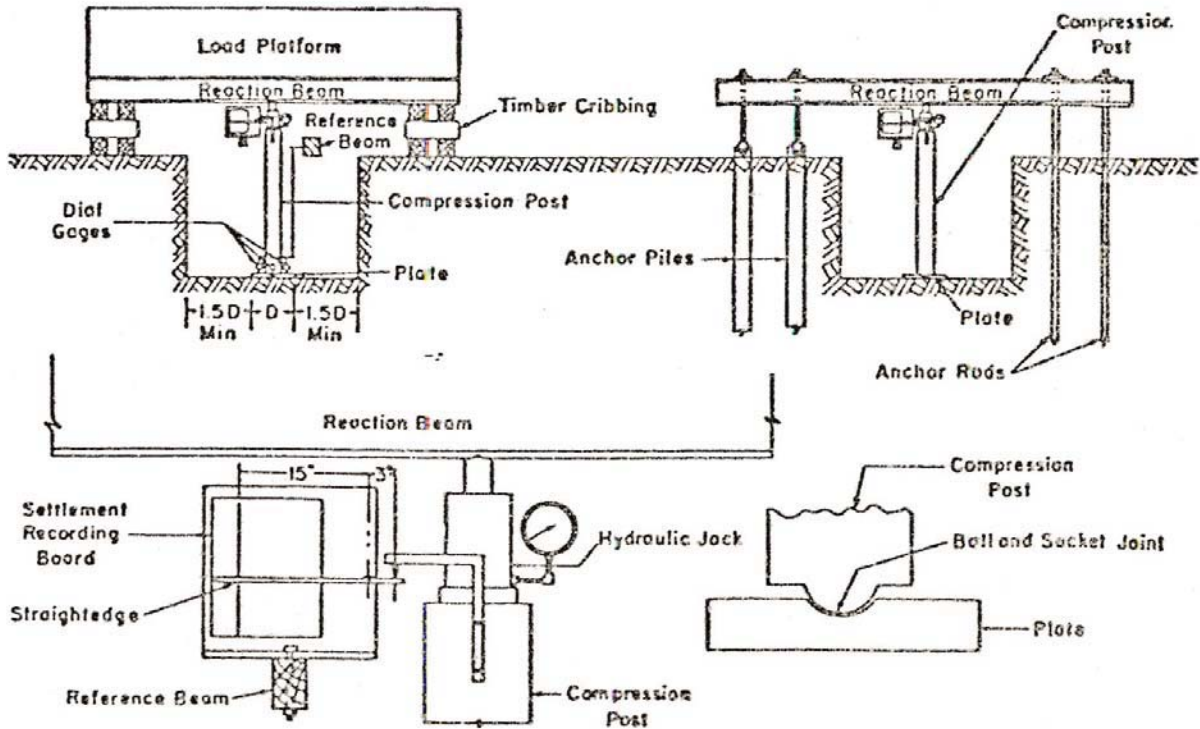


FIG. 1.—Typical Setup for Conducting Static Load Tests.



## STANDARD BALL PENETRATION TEST

### 1. SCOPE

This test method describes the penetration of a road surface, which is to be sealed, by a standard ball under the impact of a standard load, and the measurement of the embedment that takes place. Two alternative methods of measurement of embedment are given]. The results may be used to estimate the likely embedment of sealing aggregate into the road under service conditions.

### 2. APPARATUS

- i. Standard marshal compaction hammer
- ii. 19.0mm steel ball bearing
- iii. Thermometer graduated in c [0-100]c.
- iv. Cumulative dial gauge [50mm travel 0.01mm units], or circular tripod with a movable cross-bar and dial gauge [0.01mm units] or vernier callipers.

### 3. PROCEDURES

#### 3.1 Measurement with the cumulative dial gauges:

- i. Select a typical sub-lot representative of the road surface to be sealed.
- ii. Site the standard ball randomly on the sub-lot.
- iii. Rest the base of the compaction hammer on the ball and apply one blow of the falling weight then remove hammer and ball.
- iv. Place the cumulative dial gauge in position and register the depth of the penetration.
- v. Repeat steps (ii) to (iv) on at least ten sites on each sub-lot, and obtain a total accumulated depth of penetration for all sites.
- vi. Divide the total accumulated depth of penetration by the number by the number of sites tested to give the average ball penetration. Record.
- vii. Record the temperature of the road surface for each set of readings.

#### 3.2 Measurement using the circular tripod, cross-bar and dial gauge:

- i. as 3.1 (i)
- ii. as 3.1 (ii)
- iii. Place the circular tripod around the ball, so that the foot of the dial gauge or vernier callipers on the cross-bar touches the top ball, and take an initial reading of the gauge to locate the level of the top of the ball. RECORD.
- iv. Remove the cross-bar and dial gauge leaving the circular tripod in place to provide a fixed reference level.



Road Projects Division

TEST METHOD : NTTM 215.1

REVISED DATE : 06/03

SHEET : 2 OF 2

- v. Rest the base of the compaction hammer on the ball and apply one blow of the falling weight.
- vi. Remove the hammer and place the cross-bar and gauge back in position and take a reading of the level of the top of the ball. RECORD.
- vii. Record the difference between the first and second readings as the ball penetration.
- viii. Repeat steps 3.3 (ii) to (vii) at least ten times on each sub-lot and average the result.
- ix. Record the temperature of the road surface for each set of readings.

**3.3 Temperature correction of the ball penetration of bitumen surfacings**

Correct the average ball penetration of bituminous surfacings from the penetration of the surface at the temperature of test to the temperature most prevalent in the summer months using the following formula:

$$\text{Pen } T_s = \text{Pen } T_t - K [T_t - T_s]$$

Where Pen  $T_s$  = penetration depth at standard summer road surface temperature for region [mm].

Pen  $T_t$  = penetration depth at the time of the test [mm].

$T_s$  = Standard temperature of road for region [C].

$T_t$  = temperature of the road surface at the time of test [C].

$K$  = temperature susceptibility of penetration [mm/C] = 0.04mm/C.

**4. REPORTING**

Report the Pen  $T_s$  to the nearest 0.1mm.

TO MODIFY THE TEST METHOD FOR QUICKER RESULTS AND EASIER FIELD WORK YOU CAN:

- 1. Bronze the ball on the bottom of the marshal hammer.
- 2. Instead of using the reference ring, datum x-bar and depth gauge, use a tyre tread gauge to measure the indentation that the ball makes.

[This method is much quicker and is just as accurate]



Road Projects Division

TEST METHOD : NTTM 216.1

REVISED DATE : 06/03

SHEET : 1 OF 1

MEASUREMENT OF LAYER THICKNESS

1. SCOPE

This method describes the procedure for the determination of the thickness of fill, subgrade and pavement layers using direct measurement.

2. APPARATUS

- (a) Excavation tools, eg auger, pick, scoop.
(b) Rule or metal tape graduated in millimetres.
(c) Straightedge to span the hole.
(d) A pointer. A nail may be used or the pointer may be integral with the rule (optional).

3. PROCEDURE

- (a) Select a sample site.
(b) Excavate a hole to a depth at least 10mm below the lower surface of the layer to be measured.
(c) Place the straightedge on the road surface so that it spans the excavated hole.
(d) Measure the distance between the lower edge of the straightedge and the lower surface of the layer.
(e) Where there is only one layer, the distance measured is the layer thickness.
(f) Where there is more than one layer, repeat Procedure (d) to determine the distance to each layer interface.

4. REPORTING

- (a) Report the layer thickness for each layer in accordance with Table 1.

TABLE 1

Table with 2 columns: FOR LAYER THICKNESS (m) and REPORT TO NEAREST (mm). Rows show ranges like <0.5, 0.5 to 1, >1 and corresponding values 5, 10, 20.

- (b) The following information may also be reported:

- . Road Name or Number
. Chainage
. Transverse Position
. Material Type
. Date of Test

NOTES

- 1. The straightedge should be resting on undisturbed surface.
2. A pointer may be used to indicate to lower surface of any layer to reduce errors due to parallax.



## SAMPLING AND TESTING OF OVERSIZE MATERIALS (>150mm) FOR PARTICLE SIZE DISTRIBUTION

### 1. SCOPE

This Test Method sets out the procedure for the determination of the Particle Size Distribution of materials which contain particles sizes greater than 150mm. The method is applicable to Soil, Rock, Aggregates and RipRap.

### 2. APPARATUS

- (a) Large Sieves.
- (b) Power Equipment eg. Backhoe, Excavator or Front End Loader.
- (c) Platform Scales.
- (d) Bins and Buckets as applicable.
- (e) Shovels, Brushes.
- (f) Tape Measure.
- (g) A.S. Sieves.
- (h) Templates for 1,000mm, 600mm, 350mm, 300mm, 200mm and 150mm sizes.
- (i) Calibrated Weighbridge.
- (j) Prepared clean, hard, level and durable area suitable as a field work area.

### 3. SAMPLING PROCEDURE

#### 3.1 General Considerations

Sampling shall be carried out with the utmost care and integrity by properly trained personnel.

Sampling shall be conducted by means which ensure that the samples represent, as far as practicable, the true nature of the main body of material from which they were drawn.

#### 3.2 Sample Size Requirements

A bulk sample of sufficient size is required so that the accidental exclusion or inclusion of a single large particle will not significantly affect the result. The following minimum sample masses are required:

Nominal Maximum Particle Size mm	Minimum Mass of Sample for Sieving kg
150	125
200	250
300	500
350	550
600	1,450
1,000	3,750



Road Projects Division

TEST METHOD: NTTM 217.1

REVISED DATE: 06/03

SHEET: 2 OF 2

**3.3 Stockpile Sampling Aided by Power Equipment**

- (a) Randomly select five (5) increment sample locations from around the stockpile.
- (b) Using power equipment remove one (1) bucketful of material from a fresh exposed face of the stockpile (first increment sample). Place this material in a heap on a clean hard level surface and level the top of the heap.
- (c) For the next sample increment remove one (1) bucketful of material from the next sampling location and place in a heap on top of the first increment point and level the top of the heap. Avoid segregation of the material.
- (d) Repeat Step (c) for the remaining sample increments.
- (e) When all five (5) increment samples are in place, each on top of the previous, use the power equipment to remove a bucket full of material. Discard this bucket full to remove bias associated with possible segregation in constructing the sample heap.
- (f) From the remaining material in the levelled heap obtain a sample of sufficient size (representative of the material under test), to satisfy the requirements specified in Section 3.2.

**4. TESTING PROCEDURE**

- (a) Determine the tare weight of the vehicle that will transport the sample from the source area to the prepared work area at a calibrated weighbridge.
- (b) Retrieve a representative sample from the source area by means of appropriate power equipment.
- (c) Determine the gross weight of the vehicle transporting the sample from the source area to the proposed work area at a calibrated weighbridge.
- (d) Determine the total mass of the sample.
- (e) Transport the sample to the prepared work area or laboratory and place it in a heap.
- (f) Separate the oversize material (>150mm or >200mm), weigh and record the mass of the retained particles for each sieve size given in the applicable job specification. This may be performed using templates of appropriate sizes, e.g. 1,000mm, 600mm, 350mm, 300mm, etc.
- (g) The remaining sample (minus 150mm or 200mm) shall be mixed, levelled and quartered to obtain a sub-sample of minimum mass 125kg for minus 150mm material or 250kg for minus 200mm material. The minus 200mm material may be sieved over a 125mm A.S. sieve to obtain a sub-sample of minimum mass 125kg.
- (h) The sub-sample shall be tested in accordance with AS1289.3.6.1.

**5. REPORTING**

Report in accordance with AS 1289.3.6.1.

**NOTES ON TEST:**

- 1. Ensure that ground level materials do not contaminate samples when obtaining the samples from the stockpiles.
- 2. Ensure that the sample obtained for testing visually represents the subject stockpile material.
- 3. If large and unmanageable particles are encountered (i.e. large boulders) these particles shall be re-loaded on to an appropriate vehicle and transported to the calibrated weighbridge as described in Section 4 (a), (c) and (d) above. Alternatively, large boulders may be split up using a sledgehammer, jackhammer or other suitable means, to facilitate weighing. Details of such activity are to be recorded.
- 4. Photographs should be obtained of the stockpile and test sample for inclusion in the report.