Transport Roads & Maritime Services

NSW GOVERNMENT

Test method T151

Determination of absorption and compressive strength of road materials stabilised or modified with bituminous materials

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Revision Summary

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		Reformatted and Revision Summary Added. 8(e) altered	D.Dash	May 1999
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Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T151 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T151

Determination of absorption and compressive strength of road materials stabilised or modified with bituminous materials

1. Scope

This test method sets out the procedures for the preparation, curing and determination of absorption, swell and compressive strength of specimens of soil, gravel or crushed rock material, stabilised or modified by the addition of bitumen, cut-back bitumen, bitumen emulsion, petroleum tar or gas-works tar.

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

2. Apparatus

(a) A cylindrical metal mould having an internal diameter of 105 ± 0.5 mm and an internal effective height of 115 ± 1 mm (a volume of 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.

(b)

(i) A metal rammer with a 50 ± 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 ± 2 mm.

(ii) A metal rammer with a 50 ± 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 ± 2 mm.

Suitable forms of hand apparatus are shown in AS 1289. 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 concrete floor or a concrete block of at least 100 kg 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) Thermostatically controlled ovens with good air circulation, capable of maintaining a temperature within the ranges of 105-110^{O}C and 50-60^{O}C respectively

(h) 37.5 mm, 19.0 mm, 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. A suitable form of apparatus is shown in AS 1289.

(l) A bowl suitable for thoroughly mixing increments of water with the test sample. A mixing machine (11 litre capacity) may be used.

(m) Moisture measurement tins, at least 500 mL capacity, with press-on lids or other suitable seal.

(n) A 100 mL measuring cylinder

(o) A steel straightedge, a suitable size being 300 mm long, 25 mm wide and 3 mm thick, preferably with a bevelled edge.

(p) A 300 mm rule

(q) A porcelain mortar, approximately 180 mm diameter, and a rubber pestle.

(r) Metal dishes, approximately 225 mm and 350 mm diameter.

(s) Materials and equipment for measuring and capping cylindrical test specimens, such as calipers, engineers try square, plate glass 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.

(t) 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) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample at a temperature not exceeding 50^{O}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 4.75 mm 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 37.5 mm AS sieve. Discard material retained.

(d) Reduce the sample by quartering or riffling to provide a portion that will yield at least 12000 g of material passing a 19.0 mm AS sieve. Screen this portion on a 19.0 mm AS sieve. Material passing the 37.5 mm AS sieve and retained on the 19.0 mm AS sieve shall be removed and replaced with an equal mass of similar material passing the 19.0 mm AS sieve and retained on the 4.75 mm AS sieve obtained from another portion of the sample.

(e) Thoroughly mix all material in the portion passing the 19.0 mm AS sieve, and obtain by quartering or riffling two portions each of no less than 6000 g of material for preparation of two duplicate pairs of test specimens.

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. Preparation and Curing of Test Cylinders

(a) Obtain by quartering or riffling, two portions of about 3000 g mass, from the sample prepared in *Preparation of Sample (e)* above.

(b) Weigh the mould and record the mass (M_2) to the nearest 5 g. 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 castor oil. Wipe off any excess oil.

(c) Take one of the 3000 g portions and determine the mass to the nearest 1 g. Calculate the required amount of bituminous material as a percentage by mass. Weigh out the calculated amount to the nearest 1 g. Add the bituminous additive to the materials at the appropriate moisture content as determined by Test Method T150 for the particular additive content and thoroughly mix to a uniform colour. Add the quantity of water necessary to provide the optimum moisture content, appropriate for the intended compactive effort, as determined by Test Method T150. Thoroughly mix. Allow the mixture 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.

(d) Compact the mixture into the mould by the specified compactive effort. Unless otherwise specified, use Standard Compaction.

(i) **Standard compaction:** Compact the mixture into the mould in three layers not varying in compacted thickness by more than 5 mm. Subject each layer to 25 uniformly distributed blows of a 2.7 kg rammer falling freely from a height of 300 mm.

(ii) **Modified compaction:** Compact the mixture into the mould in five layers not varying in compacted thickness by more than 5 mm. Subject each layer to 25 uniformly distributed blows of a 4.9 kg rammer falling freely from a height of 450 mm.

Use only sufficient material to slightly overfill the mould, leaving not more than 5 mm to be struck off after removing the collar.

(e) From the excess mixed and moistened material place not less than 300 g in a tared moisture content tin and weigh immediately to the nearest 1 g. dry to substantially constant mass at a temperature within the range of 105^{O}C to 110^{O}C. Calculate the moisture content (w) as described in *Calculations (b)*. below.

(f) Free the material from around the collar of the mould assembly and then carefully remove the collar.

(g) 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 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.

(h) Remove the base plate and weigh the mould plus compacted specimen and record the mass (M_1) to the nearest 5 g.

(i) Eject the specimen from the mould and dry the sample to constant mass in an oven at 50-60^{O}C. Record the mass (M_3) after drying and determine the average diameter of the bottom of test specimen to the nearest 0.5 mm from several diameters (D_1) measured at right angles to each other.

(j) Place the specimen in water at room temperature to a depth of 10 mm for 72 hours.

Remove the specimen from the water, dry surface and determine the (M_4) and the mean diameter of the bottom (as soaked) of each specimen (D_2). Measure and record the average height (H) of the specimen to the nearest 1 mm.

(k) Repeat *Preparation and Curing of Test Cylinders (c) to (j)* with the other 3000 g portions to provide duplicate test specimens for the required bitumen content.

(l) Cap the specimens and carry out the procedure for compression testing as detailed in the following section.

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 not plane within 0.1 mm. Capped surfaces must be plane within 0.05 mm and be at right angles to the axis of the cylinder.

(b) Cap the test specimen 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.

7. Compression Testing

(a) Determine the average diameter (D_m)of the test specimen to the nearest 0.5 mm 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 ± 0.02 MPa per second. Record the load at failure of the test specimen to the nearest 0.5 kN.

(d) Examine the broken specimens and note the rise (if any) of moisture above the centre of the base of each of the specimens and record this rise (h) to the nearest 1 mm. Determine the moisture content of the top and bottom 30 mm of each specimen to assess the resistance to capillary rise of moisture.

8. Calculations

(a) Calculate the mass of the test specimen as compacted (M) as follows:

$M = (M_1 - M_2)$ 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 capillary rise (CR) as a percentage of the specimen height as follows:

$$CR = \frac{h}{H} \times 100\ \%$$

Where

h = capillary rise in mm.

H = height of cylinder in mm.

(d) Calculate the dry density of the test specimen as compacted as follows:

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

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

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

Where D_m = Average diameter of the test specimen

(f) Calculate the swell after absorption as a percentage as follows:

$$\text{Swell} = \left(\frac{D_2{}^3}{D_1{}^3} - 1\right) \times 100\ \%$$

Where

D_1 = diameter before absorption.

D_2 = average diameter of bottom of specimen after absorption.

(g) Calculate the mass of dry soil M_d in the compacted specimen as follows:

$$M_d = \frac{100\ \mathrm{M}}{100 + w}\ \mathrm{g}$$

Where

M = mass of material in the mould in grams.

w = moisture content as a percentage by mass.

(h) Calculate the water absorption (A) as a percentage by mass as follows:

$$A = \frac{M_4 - M_3}{M_d} \times 100\ \%$$

Where

M_3 = mass of specimen before soaking in grams.

M_4 = mass of specimen after soaking in grams.

M_d = calculated mass of dry soil in compacted specimen in grams.

9. Reporting

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

(a) Type and source of additive

(b) Additive content

(c) Amount of cutter used (if any), and moisture content at which binder was added.

(d) Moisture content at which specimens were compacted

(e) Source of water if bitumen emulsion was used

(f) Compactive effort applied.

(g) Dry density of test specimens as compacted in t/m^3 to the nearest 0.01 t/m^3.

(h) Period and conditions of curing

(i) Unconfined compressive strength, as the average of the strengths of duplicate test specimens, in MPa to the nearest 0.05 MPa

(j) Swell during absorption as a percentage

(k) Water absorption as a percentage by mass

(l) Capillary rise of water

10. Techniques

(a) 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.

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

(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 the cutter oil. In such cases, the amount of cutter added should be kept to a minimum.