NEW ZEALAND STANDARD

METHODS OF TESTING SOILS FOR CIVIL ENGINEERING PURPOSES

Part 2
Soil classification tests

2.8
DETERMINATION OF THE PARTICLE-SIZE DISTRIBUTION

TEST 2.8.1
Standard method by wet sieving

2.8.1.1
Scope
This method covers the quantitative determination of the particle-size distribution in a soil down to the fine sand size (see Note (1)).

2.8.1.2
Related documents

2.8.1.2.1
The provisions of Part 1 of this Standard are applicable to, and shall be read in conjunction with, this method of test. Reference is made to Tests 2.1, 2.8.2, 2.8.3 and 2.8.4 of this Standard.

2.8.1.2.2
Reference is made in this method of test to the following British Standard:
BS 1796 : 1976 Method for test sieving

2.8.1.3
Apparatus
(a) An appropriate range of test sieves and appropriate receivers (see Notes (2) and (3)).
(b) A range of balances of appropriate capacity and accuracy.
(c) Sample dividers, for example the multiple slot type (riffle) similar to those shown in fig. 1.2 of Part 1.
(d) A drying-oven complying with the requirements of 1.4.2 of Part 1.
(e) At least 6 evaporating dishes (a convenient size is about 150 mm diameter).
(f) At least 6 metal trays (a convenient size is about 300 mm square and 40 mm deep).
(g) Two or more large metal or plastic watertight trays, or a bucket about 300 mm diameter and 300 mm deep (convenient sizes for the trays are in the range 500 mm to 1000 mm square and 80 mm to 150 mm deep).
(h) A scoop (a convenient size is about 200 mm long and 100 mm wide) or a beaker (about 500 ml).
(j) Sieve brushes, a wire brush or similar stiff brush, and scraper.
(k) A mechanical sieve shaker (optional).

2.8.1.4
Reagents
Commercial grade reagents are quite suitable:
(a) *Dispersing agent.* A solution of 2 g per litre (0.2 %) sodium hexametaphosphate plus 0.5 g per litre sodium carbonate.
NOTE – This solution is unstable, with a useful shelf life of about one month.
(b) *Flocculating agent.* 10 ml concentrated solution of hydrochloric acid diluted to 100 ml with distilled water.

2.8.1.5
Procedure
(a) Take the sub-sample obtained in accordance with the method specified in 1.6.7 of Part 1 and sieve it through the 19.0 mm test sieve (see Table 2.8.1 and Note (2)).
(b) Clean any particles retained on the sieve by brushing, scraping, or washing until the individual particles are clean of any finer material, taking care especially with weak materials to ensure that the treatment is not removing parts of larger particles.
(c) Oven-dry the material retained on the 19.0 mm sieve, weigh to 0.1 % of its mass and record (M_1).
(d) Sieve this retained material through appropriate larger sieves as in Test 2.8.2, weigh to 0.1 % of mass M_1, the mass retained on each sieve and record.
(e) Combine all material passing the 19.0 mm sieve, thoroughly mix, weigh to 0.1 % of its mass and record (M_2) (see Notes (4) and (5)).
(f) From the thoroughly mixed material passing the 19.0 mm sieve, by quartering, by riffling, or by other suitable means, take a representative fraction of convenient mass (about 2 kg)

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and also two representative sub-samples of about 300 g each for water content determination. Weigh the representative fraction to 0.1 % of its total mass and record (M_3) (see Note (6)). Determine the water content of each sub-sample, as specified in Test 2.1.

(g) Sieve the representative fraction of the material passing the 19.0 mm test sieve through the 4.75 mm test sieve (see Table 2.8.1 and Note (2)).

(h) Clean any particles retained on the sieve by brushing, scraping, or washing until the individual particles are clean of any finer material, taking care especially with weak materials to ensure that the treatment is not removing parts of larger particles. It may sometimes be found necessary to soak the retained material in 0.2 % sodium hexametaphosphate solution for at least 1 h with frequent stirring to completely remove the finer material.

(j) Oven-dry the material retained on the 4.75 mm sieve. Sieve this retained material through appropriate sieves as in Test 2.8.2. Weigh to 0.05 % of mass M_3, the mass retained on each sieve and record.

(k) Combine all the material passing the 4.75 mm sieve, thoroughly mix, weigh to 0.1 % of its mass and record (M_4) (see Note (4)).

(m) From the thoroughly mixed material passing the 4.75 mm sieve by quartering, by riffling, or by other suitable means, take a representative fraction of convenient mass (about 300 g). Weigh this representative fraction to 0.1 % of its total mass and record (M_5) (see Notes (5) and (6)).

(n) Spread this material out in a tray, or place in the bucket, and cover with 0.2 % sodium hexametaphosphate solution. Stir well to wet the soil thoroughly and allow to stand for at least 1 h in this solution with frequent stirring.

(p) Wash the material, a little at a time, through the 600 μm test sieve nested in the 63 μm test sieve, collecting the wash water containing the silt and clay passing the 63 μm sieve (see Note (7)). Continue the washing until the particles on the sieves are clean and the water passing the 63 μm sieve is virtually clear. Take care to see that neither test sieve is overloaded in the process, with either soil or water (see Table 2.8.1). The maximum amount of soil and water on the 200 mm diameter 63 μm test sieve must at no time exceed 600 g. Rinse the material retained on the sieves into separate trays or evaporating dishes.

(q) When the whole of the sample has been washed, dry all the retained material in the oven at 105 °C to 110 °C (see Note (8)). Flocculate the suspension of silt and clay with just sufficient of the 10 % solution of hydrochloric acid and allow to settle (see Note (9)). Decant or siphon off the supernatant liquid, and dry the fine material in the oven at 105 °C to 110 °C.

(r) When dry, sieve the retained material through appropriate sieves as in Test 2.8.2. Weigh to 0.05% of Mass M_5, the mass retained on each sieve and record.

(s) Combine all the oven-dried silt and clay material passing the 63 μm sieve, weigh to 0.05% of mass M_5, and record (see Note (6)).

2.8.1.6

Calculations (see Form 2.8.1)

(a) Calculate the total dry mass of the original sample (M_T) from the formula:

$$M_T = M_1 + \frac{100M_2}{100+w} \quad \text{..... g}$$

where M_1 = dry mass of the fraction retained on the 19.0 mm test sieve (g)
M_2 = wet mass of the fraction passing the 19.0 mm sieve (g)
w = percent water content of the fraction passing the 19.0 mm sieve (%)

(b) Calculate the mass of material retained on each sieve
M (sieve aperture) and that passing the finest sieve
M (passing) as a percentage of the original sample mass M_T as follows:

(1) For fractions retained on the 19.0 mm sieve or larger, for example:
percentage retained on 37.5 mm sieve =

$$\frac{M_{(37.5\ mm)}}{M_T} \times 100 \quad \text{..... \%}$$

(2) For fractions retained on sieves between 19 mm and 4.75 mm, for example:
percentage retained on 9.5 mm sieve =

$$\frac{M_{(9.5\ mm)} \times M_2}{M_T \times M_3} \times 100 \quad \text{..... \%}$$

where M_3 = wet mass of the representative fraction of the material passing the 19.0 mm sieve (g)

(3) For fractions retained on sieves finer than 4.75 mm or for fractions passing the finest sieve, for example: percentage retained on 300 μm sieve =

$$\frac{M_{(300\ \mu m)} \times M_4 \times M_2}{M_T \times M_5 \times M_3} \times 100 \quad \text{..... \%}$$

where M_4 = wet mass of the material passing the 4.75 mm sieve (g)
M_5 = wet mass of the representative fraction of the material passing the 4.75 mm sieve (g)

(c) Sum the percentages of material retained on each sieve used, together with the percentage passing the finest sieve, and subtract from 100. This is the loss, which should not exceed 1 %.

(d) For each sieve calculate the cumulative percentage by mass of the total dry sample passing that sieve.

2.8.1.7
Reporting of results

2.8.1.7.1
Report the following values:

(a) Results in the form of a table showing to the nearest 1 % the percentage by mass passing each of the sieves used.
(b) If required, the results on a semi-logarithmic chart of the type shown in fig. 2.8.1.
(c) State the percentage loss, or that the percentage passing the finest sieve was obtained by difference.

2.8.1.7.2
State the history of the sample, for example natural state, air-dried, oven-dried or unknown.

2.8.1.7.3
State that the result was obtained in accordance with this Standard Test Method.

NOTES ON TEST 2.8.1

(1) BS 1796 discusses the main factors affecting test sieving and the results obtained, and specifies general principles to be followed concerning apparatus and procedure.
(2) *Choice of sizes of test sieves.* The sizes of the test sieves used for the test should adequately cover the range for the particular soil used, but it will not generally be necessary to use every size for every test. In the test method, test sieves of 19.0 mm and 4.75 mm aperture have been specified as convenient points for sub-sampling but the sample may be split on any appropriate sieve.
(3) Where large numbers of tests are to be carried out, it may be advantageous to have two sets of test sieves, one for the wet sieving and one for the dry sieving processes.
(4) If at this stage the sample is of convenient size to continue without further sub-sampling, the sub-sampling procedure should be omitted. If there is such a large amount of fine material that the combined sample contains too much water for convenient sub-sampling, water may be carefully removed by suitable means, but the water content shall not be reduced below natural water content. No part of the sample shall be allowed to dry significantly more than the rest.
(5) Certain soils (for example, laterites) have large amounts of the clay fraction in the interstices of the larger particles. These soils should be treated as described in this method but the large particles retained on the 19.0 mm test sieve shall be washed in sodium hexametaphosphate solution; the amount of clay removed shall be estimated and allowed for in the final calculations.
(6) If separation of the silt and clay fractions is required, then if necessary, again reduce the sample, for example by riffling and carry out a fine analysis as in Tests 2.8.3. or 2.8.4.
(7) The recovery of wet fines for the determination of loss is a very lengthy process and may *sometimes* be omitted without significant error. If omitted, it *must* be stated when reporting results, that the percentage passing the finest sieve was obtained by difference.
(8) The material retained on each sieve shall not be dried on the sieve as it is detrimental to sieves to heat them.
(9) Where flocculation could lead to other problems such as dissolution of soil material, flocculation with acetone is preferred.

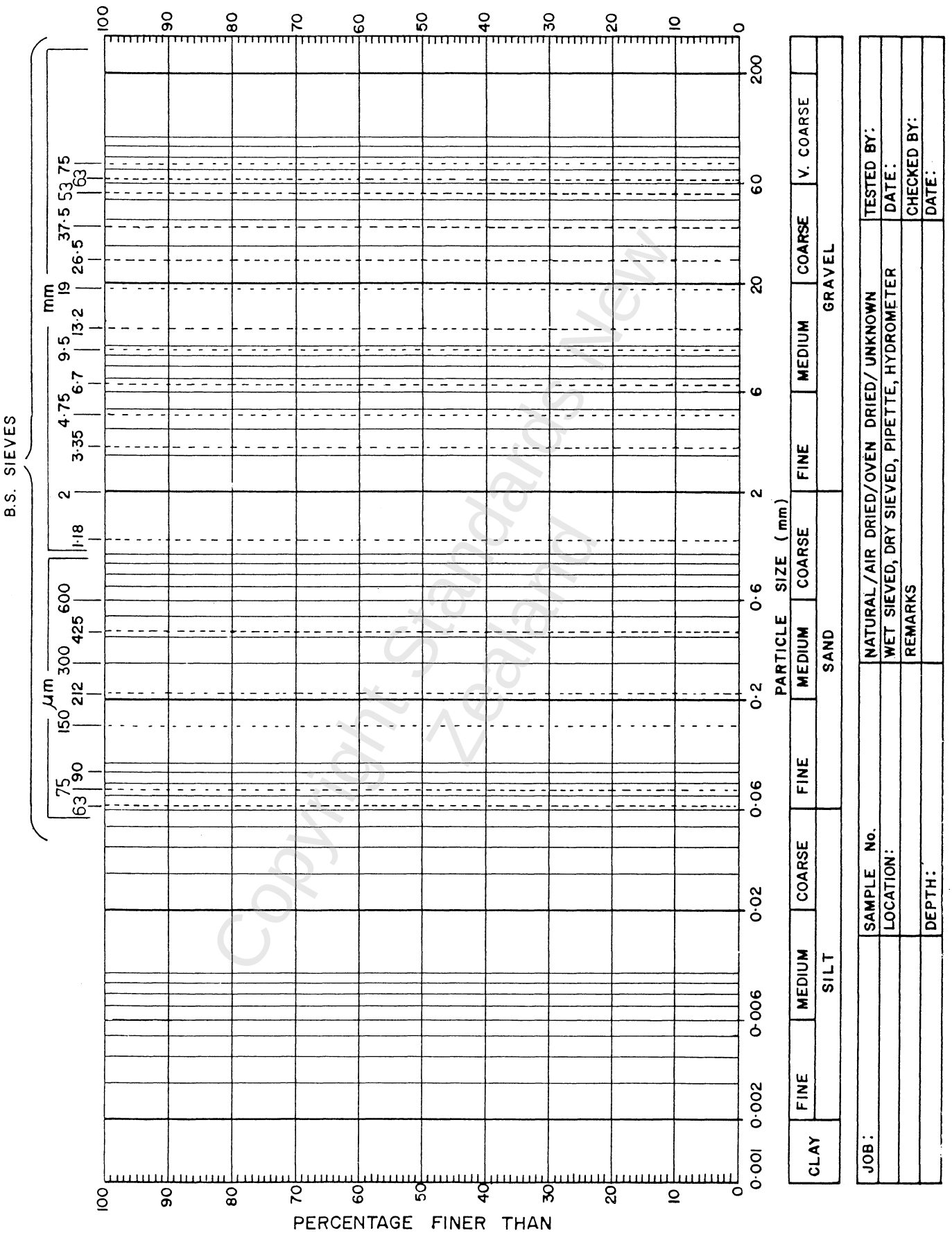

Fig. 2.8.1
CHART FOR RECORDING PARTICLE-SIZE DIS[illegible]BUTION

Table 2.8.1
MAXIMUM MASS OF MATERIAL TO BE RETAINED ON EACH TEST SIEVE AT THE COMPLETION OF SIEVING

Test sieve	Maximum mass retained on sieve of diameter shown			
	450 mm diameter	300 mm diameter	200 mm diameter	100 mm diameter
53.0 mm	10 kg	4.5 kg	–	–
37.5	8	3.5	–	–
26.5	6	2.5	–	–
19.0	4	2	1000 g	–
13.2	3	1.5	600	–
9.50	2	1	450	–
6.70	1.5	0.7	300	–
4.75	1	0.5	250	–
3.35	0.7	0.4	200	–
2.00	0.5	0.3	150	40 g
1.18	–	0.2	100	25
600 μm	–	175 g	80	20
425	–	150	70	17
300	–	125	60	15
212	–	100	50	12
150	–	100	40	10
90	–	75	30	7
63	–	50	20	5
Column 1	2	3	4	5

Form 2.8.1, 2.8.2
DETERMINATION OF THE PARTICLE-SIZE DISTRIBUTION
(Tests 2.8.1, 2.8.2)

Job:
Location:
Depth:
Test details:* Wet/dry sieving method
Test performed on fraction passing/retained on ..... test sieve
History: Natural/air-dried/oven-dried/unknown

Sample no.:
Tested by:
Date:
Checked by:
Date:

Determination of water content of material passing 19 mm test sieve

Container number			
Mass of container and wet soil	g		
Mass of container and dried soil	g		
Mass of container	g		
Mass of water	g		
Mass of dried soil	g		
Water content	%		

w ..... %

Mass of dry sample retained on 19 mm test sieve M_1 ..... g
Mass of sample passing 19 mm test sieve M_2 ..... g

Total mass of dry sample $M_T = M_1 + \dfrac{100\ M_2}{100 + w}$ ..... g

Test sieve	*Mass retained*	*Corrected mass*	*Percentage retained* $\frac{Mass}{M_T} \times 100$	*Total percentage passing*	*Maximum sieve load†*	*Sieve diameter used*
75 mm	g	g	%	%	g	
63 mm						
53 mm						
37.5 mm						
26.5 mm						
19 mm						
9.5 mm						
6.7 mm						
Passing 19 mm (M_2)						
Sample fraction passing 19 mm (M_3)						
Riffling correction, C_1 $C_1 = \frac{M_2}{M_3} =$		*Corrected values* C_1 x mass retained				
13.2 mm						
9.0 mm						
7.0 mm						
4.75 mm						
Passing 4.75 mm (M_4)						
Sample fraction passing 4.75 mm (M_5)						
Riffling correction, C_2 $C_2 = \frac{M_2}{M_3} \times \frac{M_4}{M_5} =$		*Corrected values* C_2 x mass retained				
3.35 mm						
2 mm						
1.18 mm						
600 μm						
425 μm						
300 μm						
212 μm						
150 μm						
90 μm						
63 μm						
Passing 63 μm						
Total:						

* Delete inappropriate words.

† Enter figures from table 2.8.1. If the mass exceeds the permitted maximum, the result is invalid; in this case, a smaller sample should be used or the sample sieved a part at a time.

NOTES