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by

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Preface

This guide deals with determining of particle size in sand and gravel fraction.

The guide is part of a series, which explain the execution of geotechnical classification experiments as carried out at the Geotechnical Engineering Laboratory.

The guide is constructed as follows:

- *Appertaining standards*
- *Definitions*
- *Apparatus*
- *Equipment calibration*
- *Preparing the test sample*
- *Procedure for experiment*
- *Calculation*
- *Reporting*
- *Remarks*
- *Schema for experiment execution*
- *Appendix, if any*

It is recommended that the user of this guide reads the entire guide before the experiment is started.

Numbering of figures in the text is indicated by { }.

Units are indicated by [ ], e.g. [%].

Appertaining standard

The experiment is based on and further described in the standard DS/CEN ISO/TS 17892-4.

Definition

A grain size analysis is done by determining the weight related distribution of the soil grains according to size in the sand and gravel fraction (0.06 mm – 60 mm).

The grain size is defined as the mesh width of the finest square sieve through which the particle can pass.

Apparatus

- Sieves, mesh widths must provide an indicative description of the material, smallest mesh width should be 0.063 mm {1}
- Shaker machine {2}
- Scale, weight accuracy, 01g
- Sieve brush {3}
- Bowls in corrosion resistant material
- Pressure sprayer/liquid sprayer {4}
- Tub with sieve holder {5}
- Drying oven for 50 and 105^{o}C, respectively

Figure 1: Sieves used for coarse and fine screening, and a shaker machine

Figure 2: Apparatus for wash out.

Equipment calibration

The sieves do not need to be calibrated before execution of experiment. However, these should be checked for flaws in the mesh such as holes or remaining particles.

The sieves must be calibrated annually in order to prove the actual mesh width, and it must be documented that the mesh width lies within what is approved for the sieve in question.

The calibration is done by means of calibration balls designed especially for the particular mesh width.

Preparing test sample

If more than 90% of the particles are larger than 0.063 mm, a screening must be done. If more than 10% of the particles are smaller than 0.063 mm, a hydrometer analysis must be done. If an overall grain curve is wanted, both experiments must be carried out.

The necessary weight of soil used for the test depends on the estimated D_{90} (the mesh width through which 90% of the material can pass).

Table 1: Used sample sizes depending on D_{90}.

D_{90} mm	Sample size: g
0,5	50
1,0	100
4,0	150
6,0	350
8,0	600
16,0	2.500
22,4	5.000
31,5	10.000
45,0	20.000
63,0	40.000
75,0	56.000

- A sample size is weighed (*W*) and dried at 105^{o}C to a constant weight.
- The sample is placed in the vacuum desiccator after which it is weighed (W_s) (Dry weight *A*) when it has reached room temperature, and the water content is determined.
- The dry sample is placed in a bowl, tray or tub where it is covered with water. The sample must stand for at least 1 hour with regular stirring of the sample.
  - For sample with particles larger than 5 mm, it can be necessary to part the sample and treat the coarse particles separately.

- Parts of the sample; max. 150 g, is placed on a 2 mm sieve under which a 0.063 mm sieve is placed, figure 3. It is important that there is only the sample amount on each sieve which it can carry, see table 2, which is why it may be necessary to wash out more than once.
- With the pressure sprayer, wash until the water running down on the 0.063 mm sieve is clear. If necessary, stir lightly in the sample with a brush or spatula, figure 4.
- The part of the sample on the 0.063 mm sieve is washed out, figure 5. If there is more sample than appropriate, remove some of the sample and save it in a bowl, and the wash out can be done in several steps. No pressure should be applied to the 0.063 mm sieve. If stirring of the sample is needed, do so lightly with a soft brush.
- The sample on the sieve is washed out until the water running from it is completely clear. The washed out sample is collected in a tub.
- Remnant on the sieves is collected and dried at 105^{o}C until a constant weight is achieved.
  - If the washed out sample is being used for hydrometer, the water amount can be reduced at max. 50^{o}C.
  - If the washed out sample is not going to be used, it is dried at 105^{o}C until a constant weight is achieved (W_3).
- When the sample has a constant weight, it is put in the vacuum desiccator until the temperature reaches room temperature.
- The dried sample is weighed (W_1).

If a hydrometer analysis is being done on the washed out samples, de-ionised water must be used for the wash out or the wash out can be done with tap water.

Figure 3: Wet sample on 2 mm sieve.

Figure 4: Wash out on 2 mm and 0.063 mm sieves.

Figure 5: Wash out on 0.063 mm sieve.

Procedure for experiment

Coarse screening

Coarse screening must be done if the sample is estimated to have particles over 16 mm. Coarse screening is done on sieves 63, 32 and 16 mm.

- The dried sample is crumbled by hand so that any clumps are crushed.
- The sample is screened for 20 min. in the shaker machine.
- The content remaining on the sieves is weighed.
- The screenings from the 16 mm sieve is weighed (W_2) (Dry weight B) and saved for fine screening.

Fine screening

The fine screening is usually done with the 8, 4, 2, 1, 0.5, 0.25, 0.125 and 0.063 mm sieves. In case of very uniform samples, other sieves can be used. The screenings from the 16 mm sieve is used for fine screening. Should coarse screening not be necessary, the entire sample from the wash out will be used, and, and W_1 and W_2 are therefore the same.

- Above-mentioned sieves are collected in consecutive order, and the sample is poured onto the 8 mm sieve or the sieve with the largest mesh width.
- The sieve tower is placed in the shaker machine and screened for 20 min., figure 6.
- The screening remnants on each sieve are transferred to bowls and weighed.
    - Tap a couple of times on the side of each sieve until it is removed so that any remnants fall through.
    - Each sieve is placed with the bottom up on a large piece of paper, and the backside is lightly brushed off so that particles sitting in the mesh have loosened, figure 7. On the sieves 0.5 mm and under, brushing must only be done lightly with a soft brush.

Table 2: The maximum amount on the sieves commonly used.

Mesh width mm	Maximum amount on sieve g
0,063	25
0,125	35
0,25	50
0,5	70
1	100
2	200
4	300

Figure 6: Sieve tower in shaker machine.

Figure 7: In order to empty the sieves, light brushing can be done on the backside of the sieve when placed on a large piece of paper.

Sieve remnants on each sieve must not exceed the values stated in table 2. Is this the case, the total sample is divided into smaller parts, and each part is screened individually, and the sieve remnants are the collective amount on each sieve. If the screenings on sieve 0.063 mm exceed by a few per cent, it is indicative that the wash out has been incomplete or that the specific sieve is defective.

Calculations

Screenings on the 64, 32 and 16 mm sieves are calculated in % of A.

The screenings from the fine screening are calculated in % of B. The values found are divided by 100 and multiplied by the percentage of screenings on the 16 mm sieve by which the screenings are stated in % of A.

Reporting

The screenings on each sieve in % of the dry weight of the total sample A, is plotted into a coordinate system as a function of the sieve dimension. The screening percentages are plotted in the y-axis in an arithmetic scale, and the sieve dimensions in the axis of abscissas in a logarithm scale.

The drawn curve constitutes the sieve curve. An example of grain curve can be seen in figure 8.

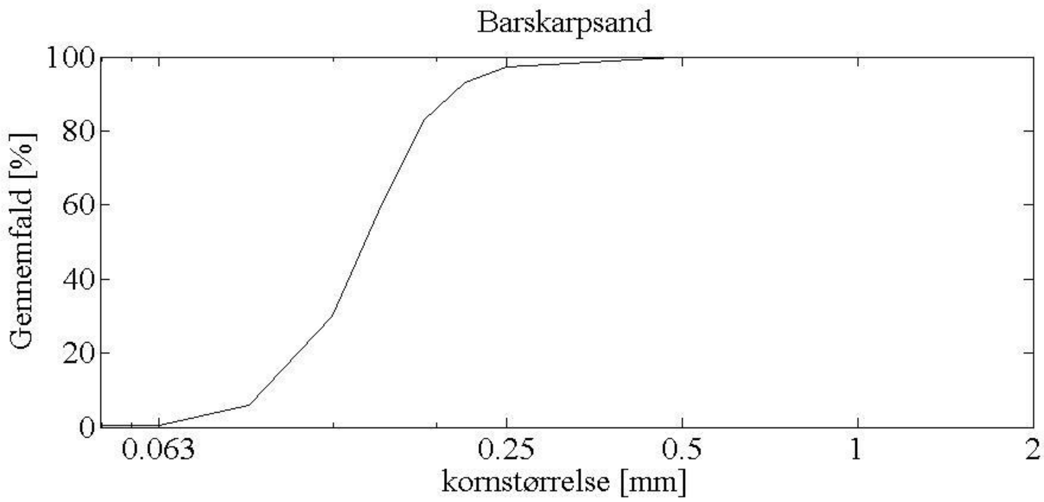

Figure 8: Example of grain size for Barskrap sand.

Remarks

The sieve remnants must not dry on the sieves as the sieves will be damaged by heating of temperatures over 60^{o} C.

The sieve remnants are considered to be finely screened when it is reduced with no more than 1 weight per cent with an additional 1 min. screening.

If the screened sample is much sorted and uniform, other grain sizes can be used. The maximum amount of these sieves can be seen in table 2 in DS/CEN ISO/TS 17892-4:2004 1st edition.

The sieves are checked for flaws or holes before each experiment.

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Sieve analysis page 1/2

Case			Case no.
Examined	to	Lab. no.	Boring no.
Controlled d.	Approved d.	Level	Appendix no.

WATER CONTENT

Sample	No	
Bowl	No	
Bowl in drying cab.	dd h	
Bowl out drying cab.	dd h	
Bowl	g	
Bowl + W	g	
Bowl + W_s	g	
W_w $(W-W_s)$	g	
W_s	g	A
$w = \frac{W_w}{W_s}$		

SAMPLE SIZES

$\text{Bowl}_1 + W_1$	g	
Bowl_1	g	
W_1	g	
$\text{Bowl}_2 + W_2$	g	
$Bowl_2$	g	
W_2	g	B
$\text{Bowl}_3 + W_3$	g	
$Bowl_3$	g	
W_3	g	

W_1 Material for Coarse sieving
W_2 Material for Fine sieving
W_3 Material from wash out
Bowl Bowl/Tub

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Sieve analysis page 2/2

Case			Case no.
Examined	to	Lab. no.	Boring no.
Controlled d.	Approved d.	Level	Appendix no.

COARSE SIEVING

Sample no	

Sieve mm	Max. load g	Bowl no	Bowl + Sieve remnants g	Bowl g	Dry sieve remnants g	Screenings g	Screenings % of A
						A	100
63	4500						
31.5	2500						
16.0	1500						
Bottom							
				Sum	A		

FINE SIEVING

Sample no	

Sieve mm	Max. load g	Bowl no	Bowl + sieve remnants g	Bowl g	Sieve remnants g	Screenings g	Screenings % of B	Screenings % of A
Bottom								
				Wash out				
				Sum control				

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