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Validation of A Method for Determining the Composition of Soil Water-stable Macroaggregates

Ke Yang, Wen Sun

[1]Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an Shaanxi, China

[2]Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd. , Xi'an Shaanxi, China

[3]Key Laboratory of Degraded and Unused Land Consolidation Engineering, Ministry of Natural Resources, Xi'an Shaanxi, China

[4]Land Engineering Quality Testing of Shaanxi Land Engineering Construction Group Co,, Ltd. , Xi'an Shaanxi, China

[5]Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi'an Shaanxi, China

Abstract

The laboratory has verified the test method for the composition of soil water stability macroaggregates, and the precision is in line with "Soil Testing Part 19: Determination of Soil Water Stability Macroaggregate Composition" (NY/T 1121. 19-2008).

Keywords

Soil water-stable macroaggregates; Method Validation.

1. INTRODUCTION

Soils contain different sizes and shapes; aggregates of aggregates with different porosity and mechanical and water stability. It is composed of colloidal cohesion, cementation and cohesion of soil primary particles that are connected to each other. Aggregates in the soil with a diameter of 0.25 mm to 10 mm are called soil macroaggregates. [1-3]

2. MAIN INSTRUMENTS AND REAGENT CONSUMABLES

Soil sieve group (with apertures of 10mm, 7mm, 5mm, 3mm, 2mm, 1mm, 0.5mm and 0.25mm); soil sieve group (with apertures of 5mm, 3mm, 2mm, 1mm, 0.5mm and 0.25mm)

Percent balance, electric heating constant temperature drying oven, electric hot plate, 1000mL sedimentation cylinder.

3. EXPERIMENTAL PROCESS

3.1. Sample Collection and Preparation

3.1.1 Sample collection

When sampling, the soil moisture should not be too dry or too wet, and it should be taken when the soil is not sticky to the shovel and is not deformed by contact. When sampling, it is taken in layers from bottom to top, and care should be taken not to squeeze the soil blocks to maintain the original structural state. Peel off the soil that is deformed by direct contact with

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the soil shovel on the outside of the clod, and evenly take about 2kg of the undeformed soil inside, put it in a closed wooden box or tin box, and transport it back indoors for use.

3.1.2 Sample Preparation

The soil brought back is gently peeled into small clods with a diameter of 10 mm to 12 mm along the natural structural surface, and the coarse roots and small stones are discarded. When stripping the sample, it should be gently stripped along the natural structure of the soil to avoid deformation due to mechanical pressure. The samples were then left to air dry.

Take a part of the above air-dried soil, crush it, pass it through a 2 mm sieve, and mix it evenly for soil moisture measurement.

3.2. Analysis Steps

3.2.1 Determination of soil moisture (dry basis) content

Execute according to the method specified in NY/T 52.

3.2.2 Dry sieving

3.2.2.1 Take an air-dried soil sample of about 500 g (accurate to 0.01 g), and the order of loading apertures is 10 mm, 7 mm, 5 mm, 3 mm, 2 mm, 1 mm, 0.5 mm, 0.25 mm The top layer of the sieve group (including the sieve cover and the sieve bottom).

3.2.2.2 After the soil samples are packed, sieve the sieve group back and forth at a constant speed until the samples are completely sieved. Remove the sieves in order from top to bottom, tapping each sieve several times with the palm of your hand on the sieve wall to shake off the agglomerates that plug the holes. Collect >10 mm, 10 mm~7 mm, 7 mm~5 mm, 5 mm~3 mm, 3 mm~2 mm, 2 mm~1 mm, 1 mm~0.5 mm, 0.5 mm~0.25 respectively mm and the soil particles at all levels <0.25 mm in the bottom box, weigh, and calculate the percentage of dry sieve aggregates at all levels (accurate to one decimal place).

3.2.3 Wet sieve

3.2.3.1 According to the percentage content of aggregates at all levels obtained by the dry sieving method, the air-dried soil samples obtained by dry sieving are proportioned to 50.00 g. In order to prevent clogging of the sieve holes when wet sieving, aggregates < 0.25 mm are not poured into the sample to be wet sieved, but this value is calculated in the calculation of the number of samples and other calculations.

3.2.3.2 Pour the proportioned sample into a 1 000 mL sedimentation cylinder, and slowly pour water along the cylinder wall, so that the water is gradually moistened from the lower part to the surface layer and reaches a saturated state. After soaking the sample in water for 10 min, pour water along the wall of the sedimentation cylinder to the marking line, plug the simple mouth, and immediately turn the sedimentation cylinder upside down until the sample in the cylinder completely sinks to the mouth of the cylinder. Then turn the sedimentation cylinder upside down until all the samples sink to the bottom, and repeat the inversion 10 times.

3.2.3.3 Clamp a set of sieves with apertures of 5 mm, 3 mm, 2 mm, 1 mm, 0.5 mm and 0.25 mm with a white iron (or other metal) sheet, and put them into a bucket filled with water. It should be 10 cm above the upper edge of the sieve group.

3.2.3.4 Turn the sedimentation cylinder upside down, and place the opening of the cylinder on the top sieve. When all the samples sink to the opening of the cylinder, remove the stopper so that the soil sample is evenly distributed on the entire sieve surface.

3.2.3.5 Slowly remove the settling cylinder and take out the settling cylinder.

3.2.3.6 Lift the sieve group slowly, sink it down quickly, and repeat 10 times (do not let the sample out of the water surface when lifting, and do not let the water surface overflow the top of the sieve group when sinking), take out the upper three sieves (5 mm, 3 mm , 2 mm), and

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then repeat the above operation 5 times with the lower three sieves (1 mm, 0.5 mm, 0.25 mm) to wash the attachments on the surface of the water-stable aggregates in the lower three sieves.

3.2.3.7 Separate the sieve groups, and transfer the samples on the sieves of all levels to the aluminum box with constant weight.

3.2.3.8 Put the aluminum box into the electric heating constant temperature drying oven, bake it at 60℃~70℃ until nearly dry, then dry it at 105℃~110℃ for about 6 hours, take out the aluminum box, cool it to room temperature in the desiccator and weigh it , repeat the operation until constant weight. Calculate the percentage of water-stable aggregates at all levels.

Note: If the soil texture is light, after dry sieving and wet sieving, there are stones, gravels, plant residues and sand in each particle size, and the stones, gravels and plant residues should be picked out. If this layer of sieves are all single sand grains, these sand grains should also be discarded, but the sand grains and fine gravels combined in the large agglomerates should not be picked out and should be included in the large agglomerates. When calculating, the mass of the soil sample should be deducted from the mass of all picked out stones, gravels, plant residues and sand, and then the mass fraction of aggregates of each particle size should be converted.

3.3. Result Calculation

The value of soil water stability macroaggregates is expressed in percentage (%) and calculated according to the following formula:

$$m_0 = \frac{m}{w+100} \times 100 \qquad \cdots\cdots\cdots \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots(1)$$

where:

m0——the weight of the dried sample, in grams (g);

m - the weight of the air-dried sample, in grams (g);

w—soil moisture content, in percent (%).

$$x_i = \frac{m_i}{m_0} \times 100 \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

where:

xi—the content of water-stable macroaggregates at all levels, the unit is percentage (%);

mi——drying weight of water-stable large aggregates at all levels, in grams (g);

m0——The weight of the dried sample, in grams (g).

$$X = \sum_i^n x_i \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad \cdots\cdots\cdots(3)$$

where:

X——Sum of water-stable macroaggregates, the unit is percentage (%).

$$P_i = \frac{x_i}{X} \times 100 \qquad \cdots\cdots\cdots\cdots\cdots \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots(4)$$

where:

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Pi—the percentage of water-stable macroaggregates at all levels in the total water-stable macroaggregates, the unit is percentage (%).

4. RESULTS

4.1. Verification of Precision

The laboratory has carried out 6 parallel analysis and determination of an actual soil sample of the same type, and the determination is carried out according to all the steps of sample analysis. The average, standard deviation, relative standard deviation and other parameters of different samples were calculated respectively. Calculate the standard deviation and relative standard deviation according to formulas 5 and 6, respectively.

$$S=\sqrt{\frac{\sum(Xi-\overline{X})^2}{N-1}} \tag{5}$$

$$RSD(\%)=\frac{S}{\overline{X}}\times 100\% \tag{6}$$

Where: S—standard deviation;

$\overline{X}$- the average value of the measurement results;

Xi—the result of a single measurement;

N—measurement times;

RSD—relative standard deviation.

Table 1. Precision test data

Parallel number		Sum of water-stable macroaggregates (%)	Water-stable macroaggregates at all levels account for the total of water-stable macroaggregates (%)						
			<0.25mm	0.25-0.5mm	0.5-1mm	1-2mm	2-3mm	3-5mm	>5mm
The measurement results(%)	1	60.1	/	19.0	37.4	20.3	4.1	10.3	9.1
	2	59.2	/	21.2	38.2	19.7	2.6	9.5	8.9
	3	59.7	/	20.8	38.3	20.9	3.1	7.4	9.5
	4	59.3	/	21.1	37.1	19.3	4.2	8.7	9.6
	5	59.2	/	18.8	38.7	20.4	2.8	9.7	9.6
	6	61.8	/	19.7	37.1	19.9	3.5	9.7	10.0
Average (%)		59.9	/	20.1	37.8	20.1	3.4	9.2	9.5
Standard deviations		0.96	/	1.07	0.69	0.57	0.67	1.03	0.39
Relative standard deviation RSD (%)		1.61	/	5.34	1.82	2.82	19.73	11.16	4.17
Absolute difference (%)		0~2.6	/	0.1~2.4	0~1.6	0.1~1.1	0.1~1.6	0~2.9	0~1.1

4.2. Verification of Actual Samples

According to the supplementary requirements for the evaluation of ecological environment monitoring institutions for the accreditation of inspection and testing institutions, the requirements of Article 17: According to the scope of application of the standard, no less than one actual sample is selected for measurement.

Soil samples were selected for testing, and parallel samples were added as required. All samples were tested in accordance with all the steps of the analysis. The data summary table is

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shown in Table 2, and the detailed sampling, process data, quality control evaluation, and actual sample testing report, etc., see the original records in the attachment one.

Table 2. Actual sample test data

Sample name	Sum of water-stable macroaggregates (%)	Water-stable macroaggregates at all levels account for the sum of water-stable macroaggregates (%)						
		<0.25mm	0.25-0.5mm	0.5-1mm	1-2mm	2-3mm	3-5mm	>5mm
I2022006-001S	14.9	/	30.6	27.3	11.3	6.0	6.9	18.0
I2022006-002S	16.7	/	28.5	27.2	12.6	8.4	7.1	16.2
Absolute difference %	1.8	/	2.0	0.1	1.3	2.4	0.2	1.8
Requirements	The absolute difference does not exceed 3%							
Result evaluation	pass							

5. CONCLUSION

5.1. Precision

The water-stable macroaggregates of an actual soil sample were measured 6 times in parallel, and the absolute difference of the sum of the water-stable macroaggregates was 0-2.6%; the 0.25-0.5mm water-stable macroaggregates accounted for the The absolute difference of the sum of the water-stable macroaggregates is 0.1-2.4%; the absolute difference of the 0.5-1mm water-stable macroaggregates to the total of the water-stable macroaggregates is 0-1.6%; the 1-2mm water-stable macroaggregates The absolute difference of 2-3mm water-stable macroaggregates in the sum of water-stable macroaggregates is 0.1-1.1%; The absolute difference between the stable macroaggregates and the total water-stable macroaggregates is 0-2.9%; the absolute difference between the >5mm water-stable macroaggregates and the total water-stable macroaggregates is 0-1.1%, which satisfies the "Soil Testing Part 19: Determination of the Composition of Soil Water Stability Large Aggregates" (NY/T 1121. 19-2008) The absolute difference between the results of two parallel determinations does not exceed the determination requirement of 3%.

5.2. Actual Samples

The verification experiment was carried out on the actual samples, and the absolute difference between the two parallel samples was not more than 3%, which met the determination of "Soil Testing Part 19: Determination of the Composition of Soil Water Stability Large Aggregates" (NY/T 1121. 19-2008) Require.

The laboratory has verified the test method for the composition of soil water stability macroaggregates, and the precision is in line with "Soil Testing Part 19: Determination of Soil Water Stability Macroaggregate Composition" (NY/T 1121. 19-2008) requirements, indicating that our laboratory has the ability to determine the composition of soil water-stable macroaggregates.

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