Department of Building Egineering

EXERCISE No. 2,3

Stone materials

- marking the volume density
- marking the density

1.0 Marking of the volume density of the hydrostatic method

Equipment and instruments *(Fig. 1)*

- dryer with a device for controlling the temperature;
- vacuum vessel;
- weight, which allows also weighting sample in water;
- desiccator with desiccant.

Fig. 1. The set for marking of volume density of stone materials

The samples preparation and conduct of the test

From the element of stone should be prepared at least six samples in the shape of cubes, cylinders or prisms. The sample volume calculated based on geometric measurements should be at least 60 ml. The samples should be numbered in a permanent way.

Each sample should be dried to constant weight at a temperature of (70 ± 5) °C and should be cool in a desiccator. Then put the sample to the vacuum vessel and gradually lowering the pressure to attain (2.0 ± 0.7) kPa = (15 ± 5) mmHg.

Maintain the pressure during (2 ± 0.2) h. Pour slowly the demineralized water, (which it has 20 ± 5 °C) to the vessel.

When the water was poured, should be maintained the pressure (2.0 ± 0.7) kPa. After this time, the atmospheric pressure should be restored in the vessel and the samples left under water for a further (24 ± 2) h.

Then, the each sample should be:

- weigh in the water and record the weight m_h;
- quickly wipe with a damp cloth and weigh the weight of sample saturated with water m_s, in the air.

Calculation

The volume density (kg/m^3) is expressed:

$$\rho_b = \frac{m_d}{m_s - m_h} \cdot \rho_{rh} \tag{1.1}$$

gdzie: m_d - weight of the sample dried to constant weight, g;
m_s – weight of the sample saturated water in air, g;
m_h – weight of the sample in water, g;
ρ_{rh} – density of water at the test temperature, g/cm^3.

Open porosity

Open porosity is expressed by the ratio (in percent) of the pore volume open to the sample volume, according to the formula:

$$p_o = \frac{m_s - m_d}{m_s - m_h} \cdot 100 \qquad (2.2)$$

gdzie: $\boldsymbol{m_d}$ - weight of the sample dried to constant weight, g;
$\boldsymbol{m_s}$ – weight of the sample saturated water in air, g;
$\boldsymbol{m_h}$ – weight of the sample in water, g;

2.0. Marking of the density in the Le Chatelier flask

Density test in the Le Chatelier flask gives sufficient measurement accuracy for building purposes. A general view of a measurement set of are shown in Fig. 1.

Fig.1 Instruments for marking density method Le Chatelier

Equipment and instruments

- pebble mill;
- sieve with square mesh side dimension of 0.063 mm;
- dryer with a device for controlling the temperature;
- laboratory balance;
- Le Chatelier flask (Fig. 1), with 0.1 ml graduations;
- desiccator with desiccant;
- thermostat that maintains a constant temperature of 20 ± 1°C.

Samples of material

Stone material should be disintegrate in a ball mill. This material must be passed through a sieve with mesh size 0.063 mm.
The powdered material should be dried to constant weight at a temperature of (70 ± 5)°C. Weigh a wieght m_e approx. 50 g of the sample with an accuracy of ± 0.1 g.

Test procedure

The deionized water pour to the Le Chatelier flask, to a level of 0. Then, add the sample powdered m_e to the flask in five portions of 10 g each.

After filling all of the portions, mix the powdered sample in a liquid. On the scale of the flask read volume V_s of liquid displaced by the weight m_e of sample, in milliliters to the accuracy 0.1 ml.

Test result

The density ρ_r [g/cm^3] is expressed as the ratio of the weight of the powdered dry sample m_e to the volume of liquid displaced by the weight m_e, according to the formula:

$$\rho_r = \frac{m_e}{V_s} \cdot \rho_{rh} \tag{2.1}$$

m_e - the dry weight of the powder sample dried to constant weight, g;
V_s - volume of the sample corresponding to the volume of liquid displaced by it (the reading on the flask) cm^3;
ρ_{rh} - the density of water at the test temperature, g/cm^3.

Total porosity

Open porosity is expressed as the ratio (in percent) of pore volume (open and closed) to the sample volume, according to the formula:

$$p = \left[1 - \frac{\rho_b}{\rho_r}\right] \cdot 100 \tag{2.2}$$

gdzie: ρ_b – volume density of the sample , g/cm^3;
ρ_r – volume of the sample, g/cm^3;

Group …………… Date……………

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Exercise 2

MARKING OF THE VOLUME DENSITY OF THE HYDROSTATIC METHOD

Sample	Weight of the dried sample m_d	Weight of the sample saturated water in an air m_s	Weight of the sample in water m_h	Volume $V = \frac{m_s - m_h}{\rho_{rh}}$	Volume density ρ_b
	g	g	g	cm^3	g/cm^3
1					
2					
3					
4					
5					
6					
				Average:	

Type of test material: ……………………………..

Test temperature [ºC] t = ……………

Density of water at the test temperature [g/cm³] ρ_{rh} = …………

Open porosity [%] $p_o = \frac{m_s - m_d}{m_s - m_h} \cdot 100 =$ ………%;

Final remarks: ………………………………...………………………………………………………

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Exercise 3

MARKING OF THE DENSITY IN THE LE CHATELIER FLASK

Sample	Weight of the sample m_e	Volume V_s	Density ρ_r
	g	cm^3	g/cm^3
1			
2			
		Average:	

Type of test material: ……………………………..

Test temperature [ºC] t = ……………

Density of water at the test temperature [g/cm^3] ρ_{rh} = …………

Total porosity [%]: $p = \left[1 - \frac{\rho_b}{\rho_r}\right] \cdot 100 =$ ………%

Final remarks: ……………………………...……………………………………………………

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