2020

DIY material test — *Determining the characteristics of existing structure*

RIBuild

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DIY material test

The building owner can carry out do-it-yourself (DIY) material tests and assess dry density, porosity, specific heat capacity, water uptake, and moisture content.

The following tools will be needed:

- Ruler or caliper (if the samples are irregular, a measuring cup can be used instead), [cm]
- Scales, [g]
- Oven, capable of maintain constant temperature at +105 °C
- Thermometer for measuring room temperature, [°C]
- Thermometer for measuring water temperature, [°C]
- Graduated container (large enough to fit the sample inside) if the sample is irregular
- Container (large enough to fit the sample inside) with low heat conductivity walls e.g. ice box
- Thin rope (strong enough to lift the sample)
- Waterproof marker, for writing on brick samples.

Steps

The test should be carried out in the following steps:

1. Before the test, brick sample(s) should be taken out from the masonry wall, cleaned from the mortar and if possible cut into a regular pieces.

2. If more than one sample is tested, a unique number to each sample is assigned and written on the sample.

3. Ruler or caliper is used to measure dimensions of regular samples. Measured dimensions of these samples (height (h), width (w) and length (l)) should be written down in Table 4.25. After that calculation of volume Vr [cm3] should be carried out as in Eq.4.7 and written in Table 4.25:

   $Vr = h \times w \times l,$ *(4.7)*

   where
   h - height of the sample, cm
   w – width of the sample, cm
   l – length of the sample, cm.

Table 4.25: Volume

Sample No.	*Height, h [cm]*	*Width, w [cm]*	*Length, l [cm]*	*Volume, Vr [cm^3]*	*Volume, Vi [cm^3]*

4. If samples are not regular, graduated container can be used to determine their volume (Step 14).

5. The oven should be preheated as close as possible to +105° C (t_1 [°C]).

6. Sample(s) are inserted in the oven, and dried until the dry mass of the sample(s) is reached. Dry mass is determined by weighing sample(s) approximately every 24 hours until the weight is stable. At this point the sample is dry. Small decrease of weight (up to 2 % of sample mass) can be neglected. Percentage of weight reduction during drying [%]:

(4.8)

$$\text{Reduction of weight} = \frac{\textit{weight before drying-weight after drying}}{\textit{weight after drying}} \; 100\ \%$$

7. Dry mass of sample(s) (m_d [g]) and t_1 should be written in Table 4.26.

Table 4.26: Weight of sample(s) and drying conditions

Sample No.	*Saturated weight m_s [g]*	*Drying temperature t_1 [°C]*	*Dry weight m_d [g]*

8. After sample(s) are weighted, they should be placed back in the oven to heat they up to the 105 °C while carrying out steps 9 – 11.

9. Container with water (mass of the water (m_w [g]) should be measured) is prepared. The container should be large enough to fit sample(s), well insulated and if possible with lid (e.g. ice box).

10. To measure the mass of water in the container, scales or measuring cup can be used. When using scales:
    • The weight of empty container is measured (m_c [g]) and container filled with water (m_{cw} [g]) is measured
    • The mass of water in container (m_w [g]) is calculated as

    $m_w = m_{wc} - m_c$ *(4.9)*

    When using measuring cup, the mass of the water is calculated from the volume, by using water density (in general water density in room temperature is 1 g/cm^3 (1 cm^3 of water is 1 g of water)).

11. The value m_w should be written down in Table 4.27.

Table 4.27: Specific heat capacity

Sample No.	*Water mass m_w [g]*	*Brick temperature t_1 [°C]*	*Water temperature t_w [°C]*	*Water temperature t_2 [°C]*

12. The container filled with water is kept in the room while it reaches the room temperature (can be done while drying samples), the water and room temperature are measured and when both temperature are equal, water temperature (t_w [°C]) is written down in Table 4.27.

13. The sample(s) is taken out from the oven and inserted in the container with water. Temperature of the water should be monitored (water can be stirred for better heat exchange) until the temperature doesn't change or starts to drop. This is temperature t_2 [°C].

14. The temperature t_2 is written down in Table 4.27.

15. When temperature t_2 is reached, leave the sample in the water until the saturated weight (ms [g]) of the sample(s) is reached. To determine saturated weight weighing of sample(s) are made approximately every 24 hours. When the weight stops increasing, the sample is saturated. Small increase of weight up to 2 % of sample mass can be neglected (see Eq. 4.10). Determination of weight increase during sample saturation [%]:

(4.10)

$$\text{Increase of weight} = \frac{\textit{weight now-previous weight}}{\textit{previous weight}} \times 100\ \%$$

16. The saturated weight of the sample ms is inserted in Table 4.26 .

When the sample is saturated, measuring cup can be used to determine volume of the sample(s) (Vi [cm3]) (Figure 4.50) (not necessary if the volume is determined in step 4):
• The measuring cup is filled with water and the reading of the measuring cup (V1 [ml]) is written down
• The saturated sample is submerged in the cup and the resulting reading of the measuring cup (V2 [ml]) is written down
• The volume of the sample (Vi [cm3]) is calculated as

$$V_i = V_2 - V_1 \qquad (4.11)$$

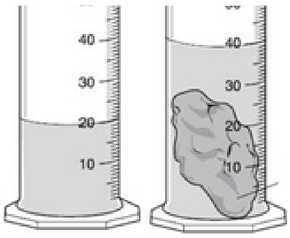

Figure 4.50: Determine volume with measuring cup.

17. Vi is written down in Table 4.25.

Sample density [g/cm³] is calculated as:

$$\text{Density} = \frac{m_d}{V_r \text{ or } V_i}$$

Sample porosity [%] is calculated as:

$$\text{Porosity} = \frac{m_s - m_d}{V_r \text{ or } V_i} \times 100\ \%$$

Sample specific heat capacity C [kJ/(kg K)]:

$$C = \frac{C_w \cdot m_w \cdot (t_2 - t_w)}{m_d \cdot (t_1 - t_2)} ,$$

C_w – specific heat capacity of water (4.1844 [kJ/(kg K)]).

Notes

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