Standard Procedure SP 0011-2:2005

Methods of determining the density of materials - Part 2: Determining the density of irregular-shaped objects (Displacement can method)

1 Scope

This procedure can be used to determine the real density of any non-porous, irregular-shaped object, or the apparent density of any hollow or porous, irregular-shaped object. The method also works for regular-shaped objects, although SP 0011-1:2005 details an easier method.

2 Definitions

density
the mass per unit volume of a uniform material

apparent density
the overall density of a hollow or porous object. It is calculated from the total mass of the object, including trapped air or gases, divided by the total volume.

3 Principle

The object is weighed to determine its mass, and is then lowered into water. The water that overflows is collected and measured. The volume of displaced water equals the volume of the object. Dividing the mass by the volume gives the density of the object.

4 Apparatus

- balance that can measure mass to the nearest 0.1 g
- displacement can, larger than the test specimen
- measuring cylinder, large enough to catch the displaced water (See step 1 in section 6.)
- thread, as thin as possible, but strong enough to hold the test specimen
- ruler measuring in centimetres

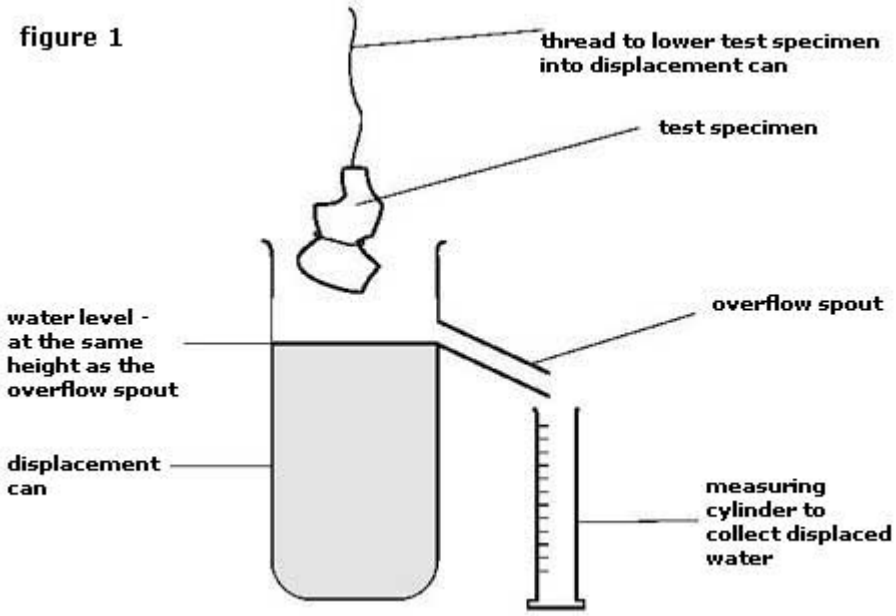
5 Test Specimens

Test specimens should be as large as possible, but small enough to fit on your chosen balance and inside the displacement can. They should not trap bubbles on their surface when submerged in the water.
At least three specimens of each material should be tested.

6 Procedure

- Measure the test specimen's dimensions to the nearest centimetre, and estimate its volume. Select the next size up measuring cylinder. (For example, for a sample 3x4x5 cm choose a 100 cm^3 cylinder.)
- Place the specimen on the centre of the balance. Record its mass in grams.
- Fill the displacement can with water, level with the overflow spout. (See figure 1).
- Place the measuring cylinder under the spout.
- Tie the thread around the specimen and lower it gently into the displacement can.
- Record the volume of water displaced into the measuring cylinder. This is the same as the volume of the specimen.

figure 1



7 Expression of Results

Calculate the density ρ of the specimen in grams per cubic centimetre (g cm^{-3}) using the formula:

$\rho = m/V$

where

m is the mass in grams

V is the volume in cubic centimetres

Note:

Density in kilograms per cubic metre (kg m^{-3}) = 1000 x density in grams per cubic centimetre (g cm^{-3})

ρ is the Greek letter rho pronounced ‘roh’.

8 Test Report

Your test report should include:
(a) reference to this standard procedure;
(b) the density of each test specimen in both g cm^{-3} and kg m^{-3};
(c) the average density of each material (calculated by adding the densities of all test specimens of that material and dividing the total by the number of specimens of that material tested);
(d) whether the real or apparent density was determined.