CONCRETE, HARDENED:
RELATIVE HUMIDITY MEASURED IN DRILLED HOLES

Key words: Concrete, hardened concrete, relative humidity

1 SCOPE
This method describes the measurement of the relative humidity of concrete by single measurements on site in a drilled hole.

2 FIELD OF APPLICATION
This method is intended for measuring the relative humidity of concrete, in a hole drilled in the concrete, for monitoring the progress of drying out of residual building moisture or drying out after, for example, water damage. The main purpose of measurement is to indicate when floors can be laid or surface coverings or treatments applied, but it can also be used when investigating the reasons for water damage. It is applicable primarily for measurements in concrete structures without temperature gradients.

3 REFERENCES
Nordtest technical report NT 1067-92.

4 DEFINITIONS

5 SAMPLING
This method does not describe how to locate the measurement point. The measurement depth and number of measurement points depend on the purpose of measurement, the design of the structure, the thickness and grade of the concrete, the material(s) in contact with the concrete, any damage etc.

One of the purposes of measurement is to monitor the progress of drying, in order to determine when a covering, coating or surface treatment can be applied. For this application, measurements shall be made at a depth of 0.2 x h in concrete that can dry out from two sides, and at a depth of 0.4 x h in concrete that can dry out from only one side, where h is the thickness of the concrete.

![Diagram showing measurement depth for monitoring moisture content of concrete prior to applying an impermeable floor covering.](image)

Measurements can also be made in order to plot moisture distribution through the material: this involves drilling holes to different depths.

The temperature should always be measured at the bottom of the hole to enable the vapour concentration to be calculated.

6 METHOD OF TEST
6.1 Principle
Measuring the relative humidity of the concrete in situ by inserting moisture sensors in predrilled holes and reading the results when steady state conditions have been established.

Allowance must be made for the characteristics of the concrete, the characteristics of the sensor and the ambient conditions.

6.2 Apparatus
A measuring instrument for indication of temperature and relative humidity must be used. The instrument and sensors must be suited for use in the field. When measuring conditions in concrete at a temperature that differs from that of the indoor air or of the moisture sensor, measurement must be comp-
llemented by temperature measurement using a surface thermometer.

After calibration, the inaccuracy of the instrument must not exceed ±2 % RH and ±0.1°C.

When making measurements in a room in which the temperature varies widely (= by more than ±3 °C during the measurement period), and/or in which there are air currents around the measurement site, e.g. at a building site, the sensor (and preferably also the measuring equipment) must be protected by a thermally insulating and draughtproof cover.

6.3 Preparation of test samples

Drill a hole in the concrete to the required depth. Clean out the dust with a vacuum cleaner and seal the hole, e.g. with a rubber plug as close as possible to the place where the moisture sensor will be positioned (i.e. close to the depth \(d_b - d_f\)), until measurement is to be made. Measurement depth \(d\) is the depth of the average level of the moisture sensor, i.e.

\[
d = d_b - \frac{d_f}{2}
\]

where:

\(d_b\) = the drilling depth, and

\(d_f\) = the height of the filter

If the measurement hole is lined with a tube, the measurement depth \(d = d_b\). Choose the diameter of the tube so that it fits closely to the hole drilled in the concrete, while having an internal diameter that is not more than 2 mm larger than the external diameter of the sensor.

6.4 Procedure

Condition the moisture sensor at a temperature close to that of the concrete and then insert it in the hole. If the diameter of the hole exceeds that stated above in 6.3, seal the hole as close to the sensor filter as possible. Leave the sensor in position for 1-24 hours, depending on the quality of the seal, the grade of the concrete and accuracy requirements.

Read the measured results (relative humidity and temperature). Measure the temperature at the bottom of the hole using a surface thermometer, taking care not to influence the temperature by inserting the thermometer. Correct the indicated value of relative humidity as indicated necessary by the results of calibration and the measured temperature. Use the following relationship for temperature correction:

\[
RH = \frac{v_s(t_0)}{v_s(t_1)} \times RH_0
\]

where:

\(RH_0\) = value as indicated by the moisture sensor [\%]

\(t_0\) = temperature as indicated by the moisture sensor [°C]

\(t_1\) = surface temperature at the bottom of the hole [°C]

\(v_s(t)\) = saturation vapour concentration at temperature \(t\) [kg/m³]

6.5 Expression of results

Express the results in terms of percentage relative humidity, temperature of the sensor and temperature at the bottom of the hole for each test point. It is necessary for the value of relative humidity to have been corrected for calibration results, temperature differences etc.

6.6 Accuracy

To the inaccuracy of the sensor must be added an inherent method inaccuracy of ±4 % RH for measurement times of 1 hour, and ±2 % RH for measurement times of 24 hours.

When making measurements with the sensor in a liner tube, the sensor should be left in position for at least 24 hours. The resulting associated method inaccuracy is ±1 % RH.

6.7 Test report

The measurement report must show the following details, as applicable:

a) The name and address of the person who made the measurements.

b) The report number.

c) The name and address of the person who ordered the measurements.

d) The purpose of measurement.

e) The measurement method and selection of test points.
f) A description of the test site/material etc.: address, floor, room, test point positions etc.

g) (Possibly) appropriate details of the structure (e.g. thickness of the floor layer).

h) (Possibly) appropriate details of the materials.

i) Date/time of drilling the holes, with details of sealing.

j) Date/time when measurement was made.

k) Description of the measurement method.

l) A list of the equipment used.

m) Any departures from the measurement method.

n) Measurement results.

o) Inaccuracy or uncertainty of measurement.

p) Date and signature.