Measures the Air-Permeability of the Cover Concrete after Swiss Standard SIA 262/1-E

Why measure the Air-Permeability of the Cover Concrete?
As the defence barrier against penetration of aggressive species (CO₂, Cl⁻, SO₄²⁻, etc.), the permeability of the cover concrete has a decisive impact on the durability of concrete structures.

Concrete composition, type of formwork, concrete processing and curing are the main factors influencing the quality of the cover concrete; hence the need to measure it on the finished structure. Swiss Standard SIA 262:2003 – “Concrete Construction” states: “The impermeability of the cover concrete shall be checked by means of permeability tests (e.g. air permeability measurements) on the structure or on core samples taken from the structure”.

The PermeaTorr™ is an instrument designed precisely to serve that purpose: i.e. to measure the permeability to air of the cover concrete on site, in a fast, repeatable, reliable and non-destructive manner. The results of the Swiss Standard method correlate well with other durability related tests, such as Chloride Penetration (ASTM C1202), Capillary Suction (ASTM C1585), Water Penetration under Pressure (EN 12390-8), Carbonation, Permeability to O₂ (Rilem-Cembureau), etc.

The method is also applicable to other porous materials such as rock, stone, clay products, ceramics, etc.

How is the Air-Permeability kT measured?
A vacuum is created inside the 2-chamber vacuum cell, which is sealed onto the concrete surface by means of a pair of concentric soft rings, creating two separate chambers.

When the vacuum reaches 30 mbar, Electro-Valve 2 is closed and the pneumatic system of the inner, measurement chamber (green in the diagram) is isolated from the pump.

The air, present in the pores of the concrete beneath, flows through the cover concrete into the inner chamber, raising its pressure Pi.

The rate of increase of pressure Pi is directly linked to the coefficient of air-permeability of the cover concrete.

A pressure regulator maintains the pressure of the external chamber permanently balanced with that of the inner chamber (Pₑ=Pi). Thus, a controlled unidirectional flow into the inner chamber is ensured and the coefficient of permeability to air kT (m²) can be calculated through suitable modelling.
**PermeaTORR Background**

The PermeaTORR is a new-generation version of the well-proved "Torrent" test method that has been successfully applied worldwide for more than 15 years. Milestones:

- Invention of the method by Dr. R. Torrent in Switzerland (1991)
- Intensive research and Laboratory and Site applications granted by the Swiss Federal Department of Transportation (1992-2006)
- Development and launching of a commercial instrument, the "Torrent Permeability Tester", by Proceq S.A. (1993)
- Included as a Swiss Standard Method ("Air-permeability on Structures") in SIA 262/1: "Concrete Construction – Complementary Specifications" (2003)
- Top performer, RILEM Recommendation TC 189-NEC, "Non-destructive evaluation of the concrete cover" (2005)
- Development and launching of a new-generation instrument, the "Permea-TORR", by Materials Advanced Services Ltd. (2008)

**What is new with the PermeaTORR?**

1. It is **faster**; the new software version allows to complete a test within 2 to 6 minutes instead of 12 minutes
2. Calibration and test **fully automated**, i.e. once the “Start” key has been activated, the operator can perform other tasks until PermeaTORR beeps that the operation has been completed
3. It is **compact** and **light** (fits in a carrying case weighing ≈ 9 kg)
4. The operation and different functionalities are activated via a **touch-screen computer** that also displays the results
5. The lot (e.g. "column C22-71, W side") and the measurement point (e.g. “2.52 m from foot, 100 mm from left edge”) can be **described**
6. The instrument measures the pressure of both chambers, so that the **reliable operation** of the system (Pe=Pi) can always be monitored. The temperature is also measured
7. **Extended range** of measurement to include ultra high permeable materials (PK6), such as certain rocks and clay tiles
8. Dust **filters** located inside both chambers of the vacuum cell
9. Pressure growth rate can be displayed graphically (ΔP⁻¹₅), allowing a **preliminary guess** of the kT value
10. Data of up to 1000 measurements can be stored in the memory and downloaded to a PC
11. **Statistical evaluation** of data (log-mean and standard deviation)
12. **Advanced features** provide full control of the test (e.g. testing above vapour pressure) and the calculation of kT under special conditions (e.g. thin elements)
13. The software can be **updated** to improve operation and accommodate future requests of our customers

**What else is required?**

A medium-small sized vacuum pump and electric power (110-240 V); see suitable models in our webpage.

The PermeaTORR measures the coefficient of air-permeability kT under the existing moisture conditions. As the moisture content of the cover concrete might affect kT, it is advisable to assess the moisture content on site following the instruments and recommendations indicated in our web-page.

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**Permeability Classes based on kT**

<table>
<thead>
<tr>
<th>Class</th>
<th>kT (10⁻¹⁶ m²)</th>
<th>Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK1</td>
<td>&lt; 0.01</td>
<td>Very Low</td>
</tr>
<tr>
<td>PK2</td>
<td>0.01 – 0.1</td>
<td>Low</td>
</tr>
<tr>
<td>PK3</td>
<td>0.1 – 1.0</td>
<td>Moderate</td>
</tr>
<tr>
<td>PK4</td>
<td>1.0 – 10</td>
<td>High</td>
</tr>
<tr>
<td>PK5</td>
<td>10 – 100</td>
<td>Very High</td>
</tr>
<tr>
<td>PK6</td>
<td>&gt; 100</td>
<td>Ultra High</td>
</tr>
</tbody>
</table>

Classes PK1 - PK4 are equivalent to ASTM C1202