

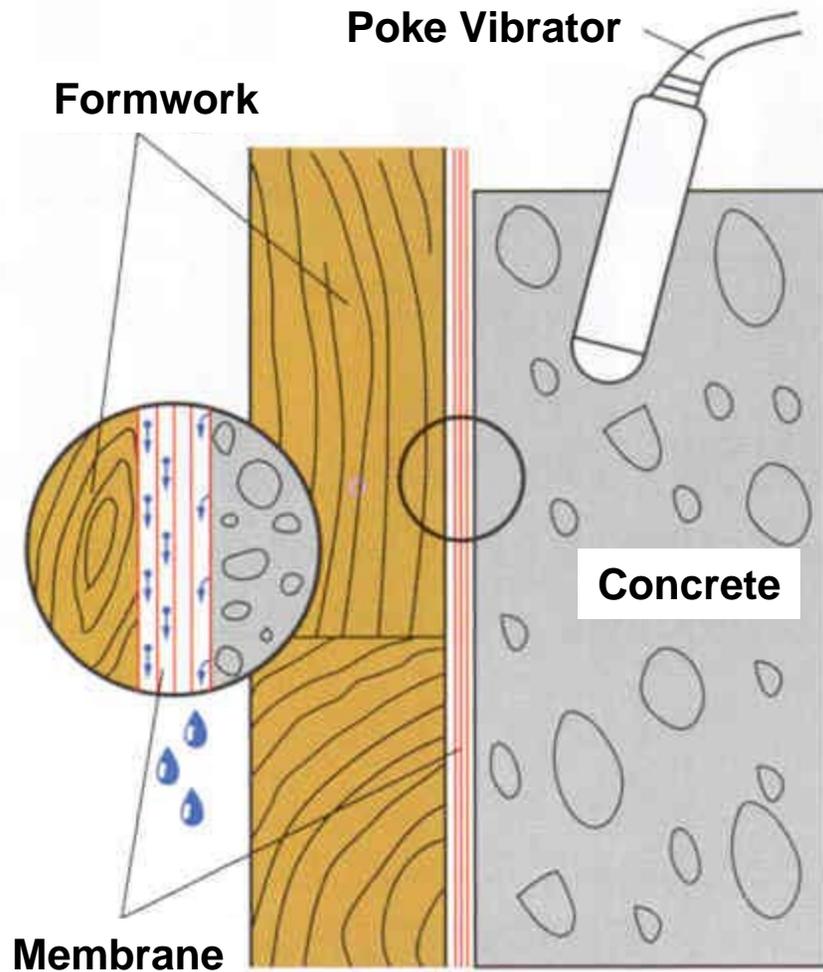
“Evaluating the long-term effectiveness
of a permeable formwork liner ”

Roberto Torrent

The short-term positive effect of permeable formwork liners on the quality of the surface has been proved by several researchers based on tests made at relatively young ages (< 1 year) .

In this research, the long-term effectiveness of “Zemdrain”, one of such liners, was investigated on a 13-year old Panel that was subjected to several NDTs. The Panel, measuring : Length = 0.61 m, Height = 0.45 m and Thickness = 0.18 m, was cast with a concrete having 140 mm slump and a $w/c = 0.55$. One face of the form was covered with „Zemdrain“ Permeable Liner. The Panel was moist cured for 7 days ($20^{\circ}\text{C} - 95\%\text{RH}$) and for the rest of its life stored in a dry room ($20^{\circ}\text{C} - 50\% \text{RH}$).

Permeable Formwork Membranes

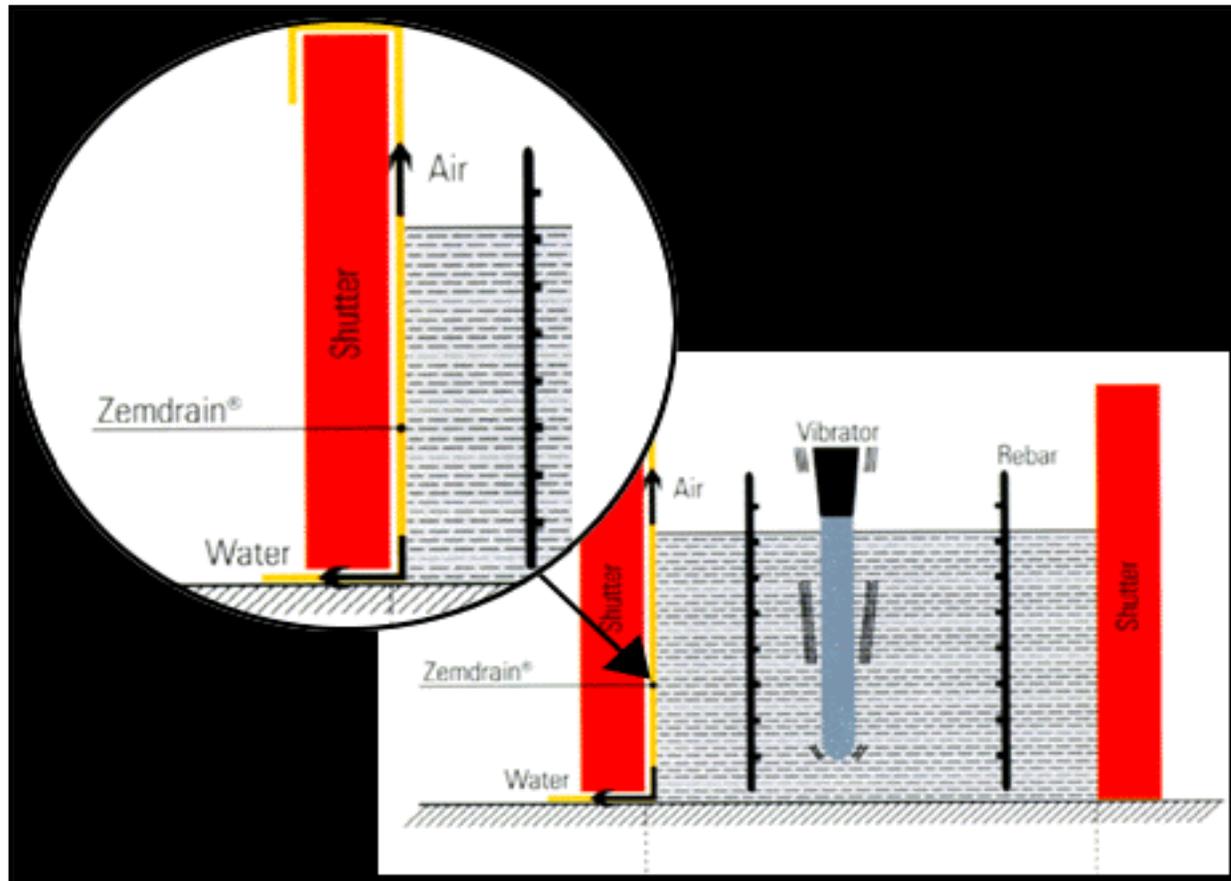


**Magnified view of the fabric of
"Zemdrain" Permeable
Membrane**

<http://www.zemdrain.com>

Permeable Formwork Membranes

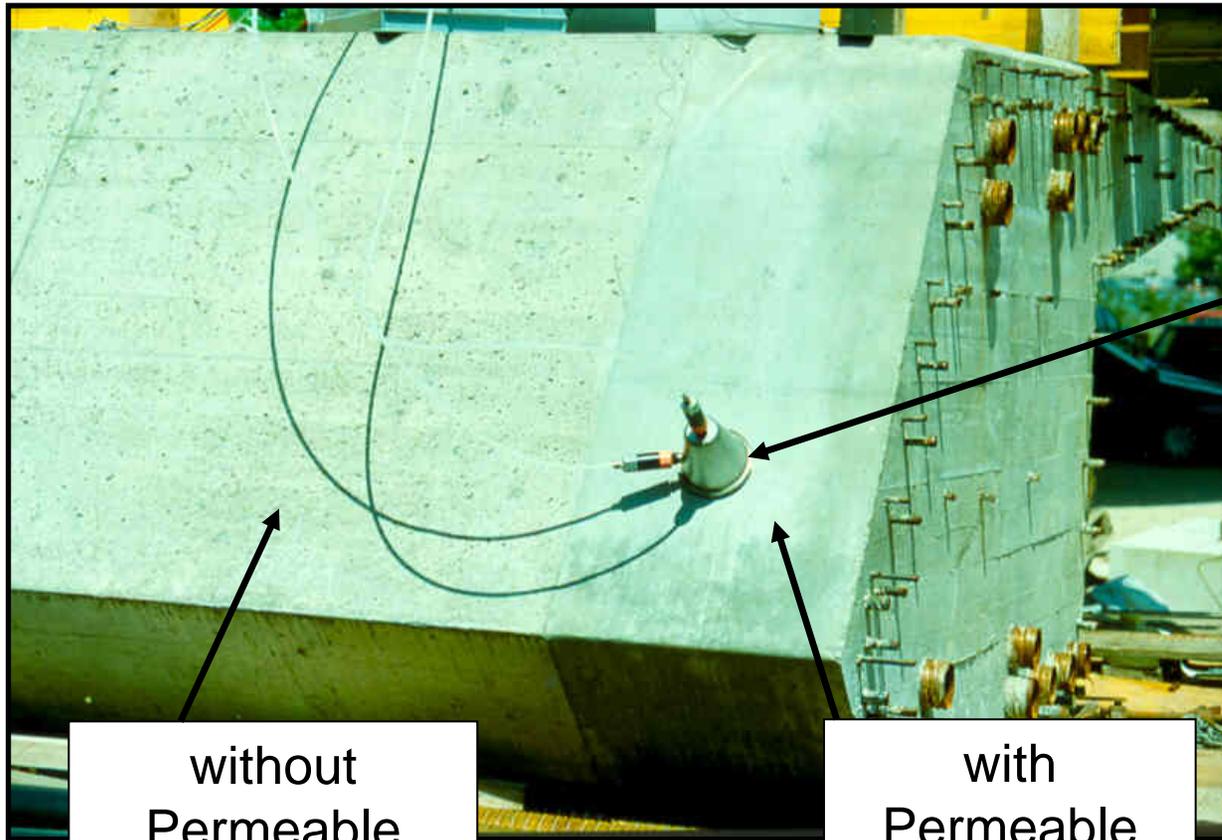
The water and the air in the concrete are expelled during vibration and are drained after traversing the membrane, which retains the cement and fine particles.



Permeable Formwork Membranes



Permeable Formwork Membranes



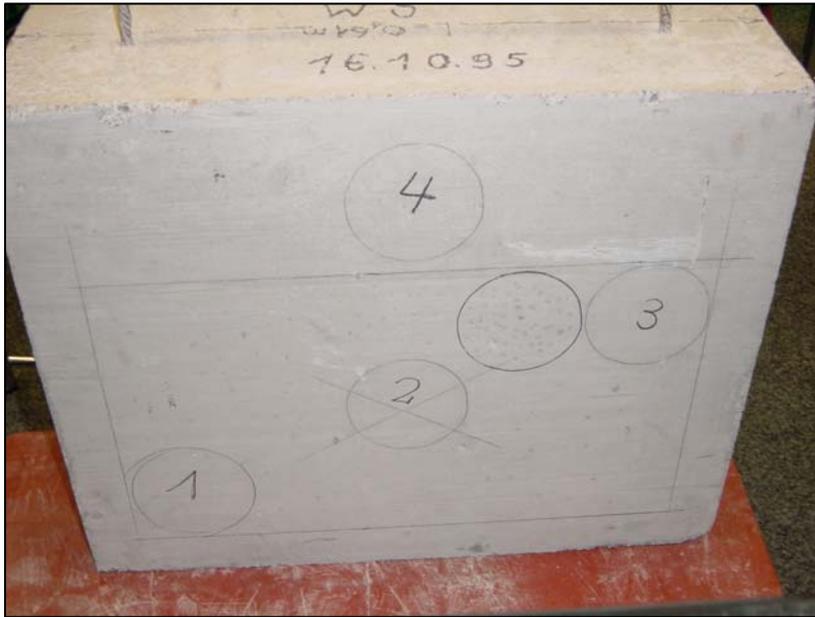
without
Permeable
Membrane

with
Permeable
Membrane

Early predecessor of
the Permea-T[®]RR

A visual indication of the effect of the membrane is the absence of air bubbles and the darker shade of gray on its surface, indicating that both air and water were drained through the liner.

Test Panel – View of both surfaces



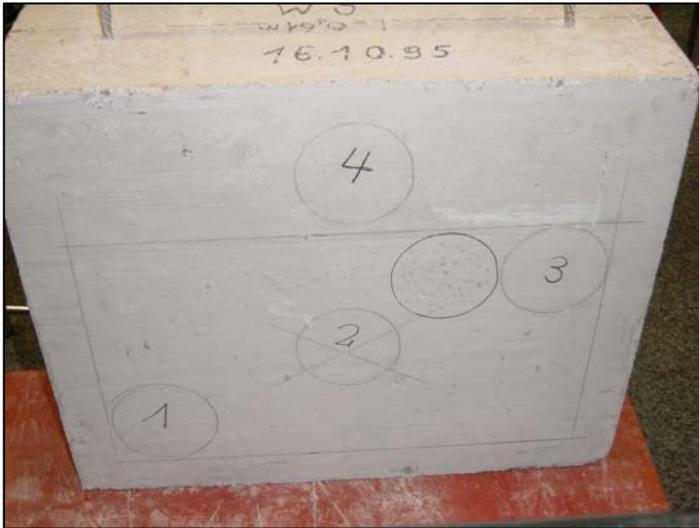
Natural Surface



„Zemdrain“ Surface

Same as in the previous picture, the “Zemdrain” surface of the Panel had almost no air-bubbles and was darker, except a fringe at the top where not enough hydraulic head existed to force the water through the membrane.

Test Panel – Rebound and kT



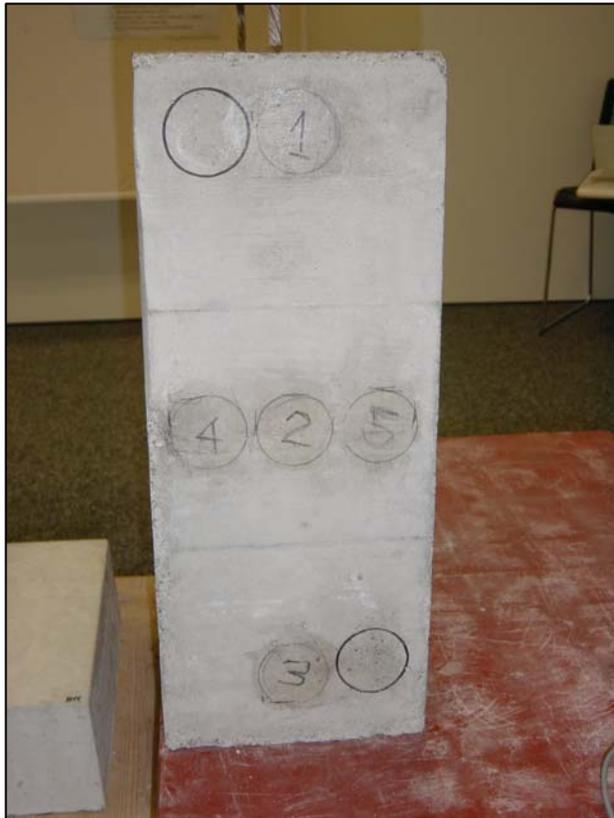
The coefficient of air-permeability kT was measured (applying the Permea-**T** \odot *RR*) on the circles 1, 2 and 3 to assess the effect of “Zemdrain” on the potential durability.



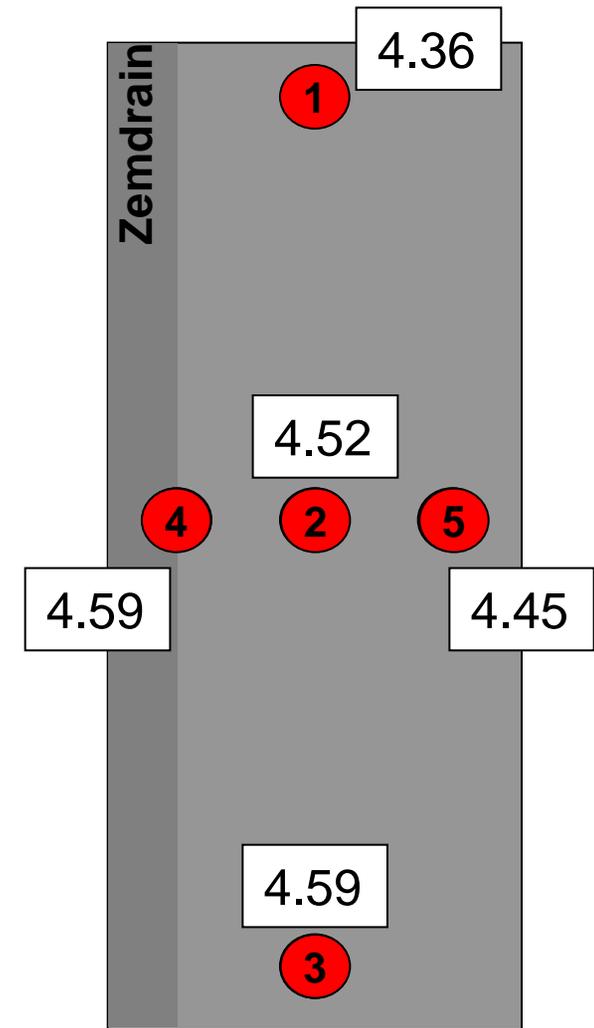
The Rebound was measured (applying the Digi-Schmidt hammer) on evenly distributed points, to assess the effect of “Zemdrain” on the surface (probably deeply carbonated at that age and storage conditions) hardness.

Only the dark area visibly affected by “Zemdrain” was investigated on both sides.

Test Panel – Applied NDT Tests

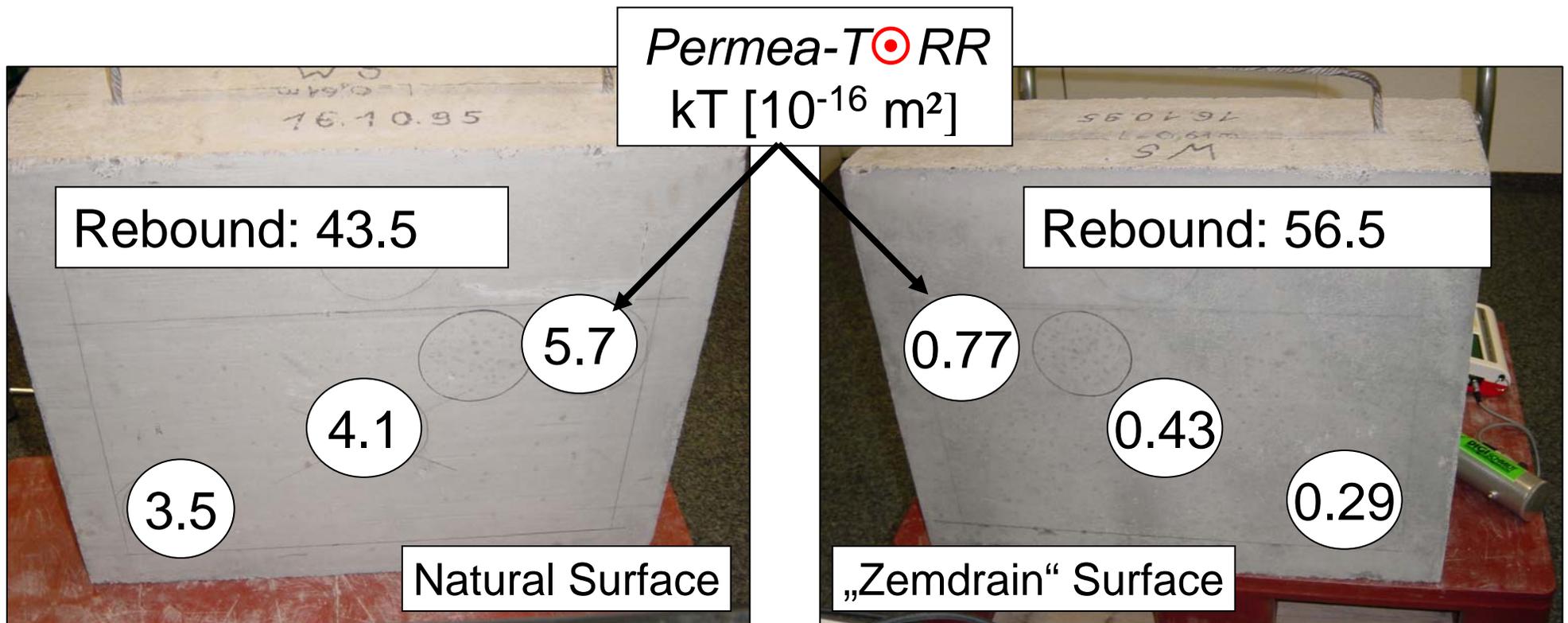


The Ultrasound Pulse Velocity (applying the PUNDIT) was measured along the length of the Panel, on the 5 locations shown in the picture. The values of UPV (km/s) obtained are shown in the sketch.



The well known effect of significantly better quality at the bottom of the element, compared with the top, can be clearly appreciated.

Test Panel – Results of Rebound and kT



The “Zemdrain” face shows a Rebound number 30% higher and a coefficient of air-permeability almost 10 times lower than the Natural surface, thus confirming the long-term beneficial effect of the liner on the hardness and “penetrability” (and hence durability) of the surface layers of the panel.