

**Table 11.** Steady State Water Permeability Coefficients for Concrete<sup>[116]</sup>

W/C	Air Content (%)	Compressive Strength (MPa)	$k$ (m/s) $\times 10^{-13}$
0.35	4.0	33.1	0.37
0.45	5.8	26.1	1.26
0.55	7.3	20.0	4.68
0.65	6.8	16.6	8.14
0.75	6.5	10.6	10.90

**Non-Steady Water Flow Test.** Due to the difficulty of establishing the steady state of flow for most concretes, either the inflow or the outflow measurements are sometimes used to express the permeability of concrete. The test set-up for this type is the same as that used for the steady state flow measurements, i.e., a suitable permeability cell is employed in order to admit water under pressure and to measure either the inflow or the outflow, or sometimes, both inflow and outflow. The main difference is that the test is not continued until a steady state of flow is achieved. Different test pressures, duration of the test, and test procedure, can be found in literature, which make the test difficult to be standardized. However, the test is capable of identifying the variation of the quality of concrete. Two in-situ tests which make use of the non-steady water flow to characterize concrete are the *Steinart Guard Ring Test*<sup>[3]</sup> and the *Autoclam Water Permeability Test*.<sup>[99][100]</sup>

**Laboratory Test.** Figure 17 illustrates the cell proposed in ISO/DIS 7032,<sup>[117]</sup> RILEM recommended method for measuring water penetration as water inflow. Test specimens can be either cylinders of 150, 200, or 300 mm diameter and height to diameter ratio of unity, or cubes of sides 150, 200, or 300 mm. Usually tests are carried out at 28 days of age. However, other ages can be chosen according to any special requirements. The specimen is kept in the cell and sealed. Water is admitted through the inlet and the outflow is measured. The recommended pressures for testing are  $P/3$ ,  $2P/3$ , and  $4P/3$ , each pressure applied for successive periods of 24 hours where  $P$  is the maximum pressure likely to be encountered by the concrete in-situ. The time and pressure at which water first penetrates the specimen and the volume of water collected during a given period at each pressure are recorded. The volume of water that has passed through the specimen in unit time for each test pressure is then calculated and expressed