Permeability
OF HIGH REACTIVITY METAKAOLIN CONCRETE

High Reactivity Metakaolin (HRM) is an engineered, high-strength, pozzolanic material. It is an economical alternative to silica fume and can be utilized in high performance concrete.

Permeability is defined as the coefficient representing “the rate at which water is transmitted through a saturated specimen of concrete under an externally maintained hydraulic gradient.”1 Permeability is inversely linked to durability in that the lower the permeability, the higher the durability of concrete, and “the permeability of concrete to water and chloride is the major factor affecting the process of corrosion of embedded metals.”2

Permeability is most frequently described by the chloride-ion permeability test that measures the passage of electrical current through a concrete specimen exposed to a solution of sodium chloride. Limits of acceptability are as shown in the table to the right.3

Permeability of concrete and the resulting level of durability are matters of great concern to designers of concrete structures. High Reactivity Metakaolin (HRM) can be a superior tool in reducing permeability.

Chloride Permeability Based on Charge Passed

<table>
<thead>
<tr>
<th>Charge Passed (coulombs)</th>
<th>Chloride Permeability</th>
<th>Typical of</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;4,000</td>
<td>High</td>
<td>High water/cement ratio (&gt;0.6), PCC</td>
</tr>
<tr>
<td>2,000 – 4,000</td>
<td>Moderate</td>
<td>Moderate water/cement ratio (0.4 to 0.5), PCC</td>
</tr>
<tr>
<td>1,000 – 2,000</td>
<td>Low</td>
<td>Low water/cement ratio (&lt;0.4), PCC</td>
</tr>
<tr>
<td>100 – 1,000</td>
<td>Very Low</td>
<td>Latex-modified concrete, silica-fume concrete</td>
</tr>
<tr>
<td>&lt;100</td>
<td>Negligible</td>
<td>Polymer impregnated concrete, polymer concrete</td>
</tr>
</tbody>
</table>

All numbers as % by weight

For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Boral Resources Technical Sales Representative or call 1-770-684-0102
Permeability of High Reactivity Metakaolin Concrete

Recent testing has shown that properly proportioned concretes using HRM as a direct replacement for silica-fume, along with a combination of high-range water reducing and air-entraining admixtures, have the ability to produce the same low levels of permeability as latex modified and silica fume concrete.

Using HRM in the concrete mix greatly aids permeability and durability in the following ways:

1. Through pozzolanic activity, HRM chemically combines with water and calcium hydroxide, forming additional cementitious compounds that result in denser, higher strength concrete. The calcium hydroxide chemically combined with HRM is not subject to leaching, thereby helping to maintain high density.

2. The conversion of soluble calcium hydroxide to cementitious compounds decreases bleed channels and void spaces and thereby reduces permeability.

3. At the same time, the above chemical reaction reduces the amount of calcium hydroxide susceptible to attack by weak acids and salts.

4. Concrete density is also increased by the small, finely divided particles of HRM that act like micro-aggregates to help fill in the tiniest voids in the concrete.

5. Alkali-silica reactivity (ASR) in concrete can induce expansion and cracking, increasing the concrete permeability. The expansion caused by ASR can be mitigated if a portion of the portland cement is replaced by a suitable metakaolin.

2 “Guide to Durable Concrete”, ACI 201.2R-92, American Concrete Institute, Section 4.4.2, April 1992.