Build something great™

BORAL RESOURCES

# Fly Ash DECREASES THE PERMEABILITY OF 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.

Permeability is most frequently described by the chloride-ion permeability test, which measures the passage of electrical current through a concrete specimen exposed to a batch of sodium chloride.[2] Limits of acceptability are as shown in the table below.[3]

**Chloride Permeability Based on Charge Passed**

| Charge Passed (coulombs) | Chloride Permeability | Typical of |
|---|---|---|
| >4,000 | High | High water/cement ratio (>0.6), PCC |
| 2,000 – 4,000 | Moderate | Moderate water/cement ratio (0.4 to 0.5), PCC |
| 1,000 – 2,000 | Low | Low water/cement ratio (<0.4), PCC |
| 100 – 1,000 | Very Low | Latex-modified concrete, silica-fume concrete |
| <100 | Negligible | Polymer impregnated concrete, polymer concrete |

**Permeability of concrete and the resulting level of durability are matters of great concern to designers of concrete structures. Fly ash can be a valuable tool in reducing permeability.**

Recent testing has shown that properly proportioned concretes using a combination of fly ash, normal or high-range water reducing admixtures, and air entraining admixtures have the ability to produce the same low levels of permeability as latex modified and silica-fume concretes.

Fly ash increases the cementitious compounds, minimizes water demand, and reduces bleed channels – all of which increase concrete density. These factors yield concrete of low permeability with low internal voids. Durability is increased with regard to freeze-thaw damage and disintegration from attack by acids, salts or sulfates.

1 "Admixtures for Concrete", American Concrete Institute, Journal of ACI Proceedings, Vol. 60, No. 11, November 1963, p. 1512.
2 "Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete", American Association of State Highway and Transportation Officials, AASHTO T277-89, Washington, DC.
3 Suprenant, Bruce A., "Testing for Chloride Permeability of Concrete", Concrete Construction, July 1991.

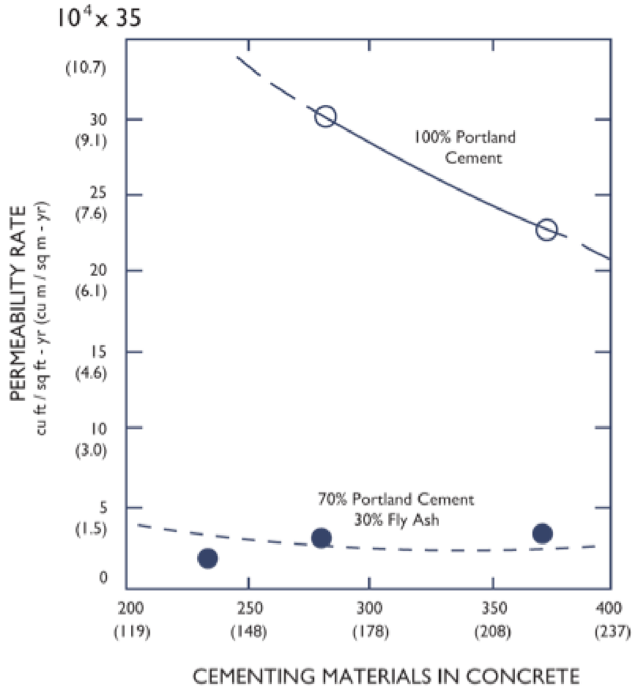
**For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Boral Resources Technical Sales Representative or call 1-770-684-0102**

Revision Date: 1.15.18

# Fly Ash DECREASES THE PERMEABILITY OF CONCRETE

**Fly Ash Helps Five Ways**
Using fly ash in the concrete mix greatly aids permeability and durability in five ways:

1. Through pozzolanic activity, fly ash chemically combines with water and calcium hydroxide – forming additional cementitious compounds which result in denser, higher strength concrete. The calcium hydroxide chemically combined with fly ash is not subject to leaching, thereby helping to maintain high density.
2. The conversion of soluble calcium hydroxide to cementitious compounds decreases bleed channels, capillary 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, salts or other sulfates.4
4. Concrete density is also increased by the small, finely divided particles of fly ash which act like micro-aggregates to help fill in the tiniest voids in the concrete.
5. Fly ash provides a dramatic lubricating effect which greatly reduces water demand (2% to 10%). This water reduction reduces internal voids and bleed channels and keeps harmful compounds out of the concrete.




Permeability of concrete with and without pozzolan. Elfert, R.J. "Bureau of Reclamation Experiences with Fly Ash and Other Pozzolans in Concrete", Third International Ash Utilization Symposium, 1973, p. 14.

4 "Fly Ash Increases Resistance to Sulfate Attack", U.S. Department of the Interior, Bureau of Reclamation, Research Report No. 23, 1970, p. 5