

## An Alternative to Silica Fume?

Material Service and CTL measure admixture's performance.

By Don Marsh, *Concrete Products*, November 1994

Research by one of North America's forerunners in commercial high performance concretes confirms increased strength, lower permeability and greater chemical resistance achievable in mixes containing High Reactivity Metakaolin (HRM), a white pozzolanic admixture. Investigators from Chicago's ready-mix mainstay, Material Service Corp., and Skokie, Ill.-based materials testing consultant CTL, Inc. report that the silicate compound yields performance comparable to silica fume, the past decade's most touted concrete admixture.

During a recently completed, year-long investigation, they compared HRM and silica fume modified concrete test specimens' compressive strength, drying shrinkage, freeze-thaw resistance, air void distribution, soluble chloride levels and other standard engineering properties. Testing encompassed a control and four mixes of HRM and silica fume slurry at 5 and 10 percent addition by weight of cement. Mixes were designed with Type I cement at targets of 4 to 7 in. slump, 0.40 water-cement ratio, and 5 to 7 percent air contents. According to Material Services' Art King, director of technical services, the results suggest that HRM admixtures could offer producers and contractors higher performance concretes plus benefits relating to ease of dispersability, mix-color neutrality and a 25 percent or greater reduction in super-plasticizer requirements for comparable work-ability.

Derived from kaolin, HRM is first refined to remove impurities, then kiln processed at high temperatures and ground to a fine powder with average particle size of less than 2 microns – compared to 0.1 micron for concrete-grade silica fume. "The powder reacts in concrete mixes with calcium hydroxide (free lime) formed during portland cement hydration," explains CTL's Ron Burg, principal investigator. "The reaction converts the compound to beneficial calcium aluminate and calcium silicate products which increase the cementitious value." The reactive properties are due to available silicon and aluminum, he adds, which also help accelerate the bonding phase for the matrix.

Material Service and CTL conducted the testing on HRM at the request of Englehard Corp., Specialty Minerals and Colors Group, Iselin, N.J. The company is marketing HRM under the trade name MetaMax and reports that it will target high performance applications.

<b>High Reactivity Metakaolin vs. Silica Fume</b>					
<b>SPECIMENS</b>	<b>CONTROL</b>	<b>HRM</b>		<b>SF</b>	
		<b>5%</b>	<b>10%</b>	<b>5%</b>	<b>10%</b>
<b>Mix designs (yd.<sup>3</sup>)</b>					
Coarse aggregate (lbs)	1,745	1,768	1,744	1,778	1,745
Fine aggregate (lbs)	1,240	1,230	1,150	1,174	1,156
Type I cement (lbs)	658	660	656	658	658

Type F high range water reducer (oz)	65	100	115	137	179
Total water (lbs)	268	260	263	261	264
W-to-c ratio	0.40	0.40	0.40	0.40	0.40
W-to-c+p ratio	0.41	0.38	0.36	0.38	0.36
<b>Properties</b>					
Slump (in.)	6.25	6.75	4.75	7.0	4.5
<b>Compressive strengths (psi)</b>					
7-day	4,810	6,900	7,610	6,350	6,390
28-day	5,950	8,480	9,150	8,040	8,360
360-day	8,580	11,350	10,460	9,210	9,910
<b>Chloride ion permeability (coulombs)</b>	4,832	--	754	--	878
<b>Modulus of elasticity – 28 days (ksi)</b>	4,805	5,115	5,640	5,435	5,590
Notes: Specimens were batched at Material Service's Yard 1 in Chicago and dispensed from mixer trucks. HRM powder dosages were added to the trucks. Silica fume was introduced with mix water as a predispersed slurry. Water contents recorded include quantities in water reducers and silica fume slurry.					

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