

**A custom-engineered, high performance, pozzolanic mineral additive for use in white cement, mortar, and concrete products**

Technical Bulletin 05-03

## Enhanced Durability through Use of VCAS Pozzolans

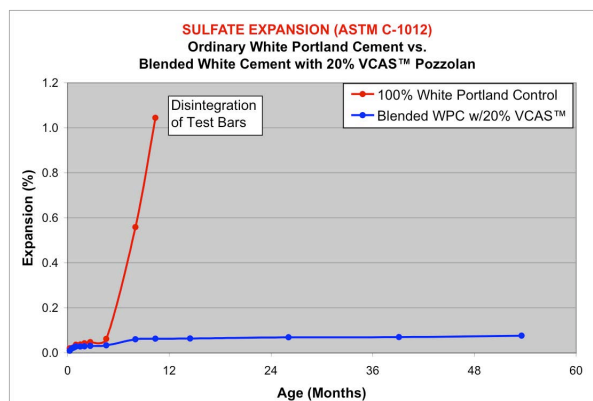
VCAS pozzolans are value-added supplementary cementing materials that exhibit pozzolanic activity similar to metakaolin and silica fume when tested by ASTM C618 and ASTM C1240. VCAS pozzolans react with calcium hydroxide produced during the hydration of Portland cement to form additional cementitious compounds such as calcium silicate and aluminosilicate hydrates. Pozzolans are used to increase concrete strength, density, and resistance to chemical attack as well as control efflorescence. This Bulletin provides some further information requested by customers on how VCAS pozzolans can improve the durability of concrete.

### Improved Sulfate Resistance of White Concrete

The production of white Portland cement (WPC) requires significant changes in the mineral feed to the kiln, largely to reduce the iron content responsible for color. As a consequence, the mineralization of the resulting WPC clinker is somewhat different from ordinary grey Portland cement (OPC). It is well known that WPC is inherently unstable when exposed to sulfate service environments, typically found in coastal regions of the southern United States and elsewhere. This has limited the broader use of white concrete to areas and applications not affected by sulfate.



*Sulfate induced deterioration of concrete*



VCAS pozzolans provides white Portland cement with superior resistance to sulfate attack. The graph above right shows the excellent dimensional stability of a white cement mortar with 20% VCAS pozzolan replacement tested by ASTM C1012 after over 4 years of exposure. Under these harsh test conditions, the 100% WPC control mortar disintegrated in less than 200 days. The VCAS pozzolanic white cement has sulfate resistance comparable with or better than Type V cement.

### Control of Alkali-Silica Reaction

VCAS pozzolans are also very effective at controlling the deleterious expansion caused by alkali-silica attack in concrete. This can be a particular problem in architectural concretes and precast products that must use light colored or decorative aggregates. Alkali silica attack in concrete involves a delayed reaction between the reactive silicates (e.g. chert, opaline silica) in the aggregate and the alkalis



*ASR (alkali-silica reactivity) deterioration of concrete*

produced by Portland cement hydration. Pozzolans such as VCAS are effective at sequestering the aggressive cement alkalis, thereby reducing considerably the attack on the susceptible aggregates.

When tested by the ASTM C441 method, mortars prepared with 20% VCAS-micronHS pozzolan replacement typically showed 99% reduction of expansion at 14 days (0.0045 vs. 0.337 for the control). VCAS-8 pozzolan typically exhibited 85% reduction of expansion at 14 days.

### **Reduced Permeability and Chloride Ion Penetration**

The supplementary cementing reaction of VCAS pozzolans provides increased strength and densification of the cementitious matrix which has the beneficial effect of significantly reducing the porosity and permeability of concrete. One consequence of this is that concretes incorporating VCAS pozzolans will have reduced chloride ion penetration (ASTM C1202) making them less susceptible to chloride-induced corrosion of embedded reinforcing steel.

### **Reduced Efflorescence and Staining**



*Unsightly staining in a building using white concrete*

In much the same way that the sequestering of cement alkalis reduces alkali-silica attack, VCAS pozzolans are also very effective at reducing both short-term (lime-rich) and long-term (alkali-rich) efflorescence and staining in buildings and structures using white cement concrete. This property will also help the designer and architect achieve better color retention and matching in decorative and colored concretes and mortars used in applications such as cladding panels, roof tiles, swimming pools, terrazzo, and stucco.

### **Customer Support**

Vitro Minerals specialists are always available to work closely with the customer to help optimize mix designs to maximize the advantages of VCAS pozzolans. Data sheets for VCAS-micronHS and VCAS-8 can be found on Vitro's website, [www.vitrominerals.com](http://www.vitrominerals.com), along with more information on pozzolans.