TECHNICAL BULLETIN # 6

Sulphate Resistant Concrete using Type HSe (Type HS equivalent) cement

For almost a century, Alberta concrete producers have been making durable products to withstand the widespread prevalence of sulphate rich soils and ground waters that epitomize much of the subsurface landscape of this province. “Kalicrete” (known today as Type HS cement) was developed and introduced to the Alberta market by the Canada Cement Company in 1930. It was purported to be the solution to placing concrete in high sulphate conditions. It has been employed very successfully for over 80 years. Type HS cement is still available but on a decreasing basis as combinations of Type GU (General Use) or Type GUL (General Use Portland limestone) cement with various supplementary cementitious materials (SCM’s) have proven to provide an equivalent solution along with several additional performance and durability attributes.

Today CSA A23.1 recognizes multiple approaches to providing durable cementing materials for long-lasting concrete for use in High Sulphate exposure conditions (see CSA A23.1-19 Table 3).

The first approach involves the traditional one of using a Type HS (Highly Sulphate Resistant) cement. The second approach developed in the 1980’s is to use blended cements (combinations of cements and SCM’s) that have supporting test data to demonstrate their performance to either Type MSb/HSb or MSLb/HSLb standards. Finally, the most common approach used by many Alberta concrete producers is to combine Type GU or Type GUL cements with an appropriate proportion of one or more SCM’s to provide an HS equivalent or **HSe** cement during the batching process. As with blended cements, the performance of the combined cementing materials must be supported by laboratory testing as per CSA A3004-C8. This information is quite often available from local cementing materials suppliers. In each case above the cementing materials are combined in concrete with an appropriate proportion of coarse and fine aggregates, chemical admixtures and must always respect a maximum water to cementitious materials ratio(W/CM) for the corresponding sulphate exposure class S-1, S-2, and S-3.

Thomas noted in 2013 and reiterated in 2016 that “With the exception of some Class C fly ashes that contain CaO (calcium oxide) contents in excess of 18% to 20% and possibly C_3A, SCM’s improve sulfate resistance by (Thomas 2013):

(a) Reducing the rate of ingress of sulfate ions due to increased resistance to fluid penetration;
(b) Diluting and, through pozzolanic reactions, reducing the content of calcium hydroxide in the paste (needed for gypsum and ettringite formation);
(c) Diluting the amount of C_3A in the total cementitious binder; and
(d) Possibly altering hydrated aluminate phases to ones less susceptible to sulfate attack, e.g. strätlingite."

In conclusion, ongoing laboratory testing and decades of field experience in Alberta confirm the performance of moderate C_3A cements with local SCM's in concrete exposed to sulphate conditions. Furthermore, this approach improves sustainability through lowered carbon footprint while continuing to provide durable concrete.

References:

1) CSA A23.1:19/A23.2:19: *Concrete materials and methods of concrete construction/ Test methods and standard practices for concrete.* CSA Group. Toronto, ON Canada 2019

2) Thomas, M. D. A. and Hooton, R. D., *Sulphate Resistance of Mortar and Concrete Produced with Portland Limestone Cement and Supplementary Cementing Materials*, Portland Cement Association, SN3285, Skokie, Illinois, USA, 2016, 25 pages.