NEW TECHNOLOGY OF SUPERPLASTICIZERS

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Contributing Writer

In North America, the use of high range water reducers has steadily increased since their introduction back in the late 1960s. Primarily utilized for high performance or specified applications in the beginning, superplasticizers are increasingly being used in day-to-day commercial concrete production.

In Canada, the two main types of superplasticizers historically used were based either on naphthaline or melamine chemistries. While commercial modifications to these products have been ongoing by various manufacturers, major limitations remain in the form of effective slump retention and variable setting times especially at the higher dosage ranges. These chemistries function by a singular dispersion method referred to as electrostatic repulsion. This is a process by which the cement particles become negatively charged and repel each other temporarily. Due to the limited dispersion capability of this chemistry, water reduction values are limited to around 25 per cent at the high end. Additional dosages of conventional superplasticizers can result in unacceptable delays in set.

In the late 1980s, patents were issued in Japan for the commercial use of polycarboxylate polymers in concrete. Known generically as polycarboxylate ethers (PCE), this chemistry has opened new frontiers in concrete performance, one example being in the increased use of self-consolidating concrete.

One of the major advantages of this chemistry is that the PCE molecule can be synthesized for optimal performance with a particular cement chemistry or desirable characteristic (ie. slump retention, normal set).

While Japan and Europe have established manufacturing plants for this chemistry, North America currently has only one plant dedicated to manufacturing the PCE chemistry for the concrete industry. This plant, owned by Degussa Admixtures Inc., opened in 2003.

The molecular structure of PCE consists of a negatively charged backbone similar to traditional dispersion chemistries. In addition to the backbone, there are grafted polymer side chains. What this imparts is a "dual" mechanism dispersion function on the cement grains. The dispersion mechanism consists of both an electrostatic repulsion and a steric hindrance effect provided by the side chains. This chemistry can be synthesized to suit many different characteristic requirements for the concrete application. Based on the type of PCE admixture, the following benefits can be derived:

- Linear water reduction based on dosage up to 40 per cent
- No extension of initial set due to retardation
- Extended slump retention as needed
- Normal viscosity at low water/cement ratios
- 1/2 - 1/3 the dosage of conventional superplasticizers
- Increased efficiency with air entraining agents
- Up to two times the early (24 hr) strength gain of conventional SPs

With the predictable and wide range of water reduction capabilities of PCE chemistries, it has become possible to design and produce self-consolidating concrete mixes which meet the most demanding performance specifications for structural and general commercial use.

As the downward trend of available skilled workers for placement and handling of concrete continues, this concrete mix technology has been the fastest growing segment of ready mix concrete design. Polycarboxylic SCC mixes can be produced with stable slump flows in excess of 700 mm with normal setting and adjustable viscosities for horizontal or vertical applications.

Another benefit of PCE water reduction capabilities is it enables production of ready mix concrete with a normal type 10 (GU) cement that performs comparably to a pre-cast mix containing a type 30 (HE) cement. The main application of this concrete has been rapid early strength partial and full depth concrete repairs. PCE-designed ready mix concrete can produce compressive strengths in excess of 30 Mpa in six hours or less without external heat curing. Municipalities can reduce the cost of traffic diversion and improve site safety at a cost savings well in excess of the delivered concrete cost.

From a concrete producers perspective, PCE-based admixtures can provide an operational benefit to dispensing headaches. Specific PCE-based admixtures can be utilized for normal, mid, and high-range plasticizing simply by adjusting the dosage, thereby, reducing the number of required dispensing systems in often overcrowded or limited product handling batch plants. From a quality control design standpoint, the use of PCE-based admixtures will allow concrete mix designs to incorporate a higher percentage of supplementary cementing material without adversely affecting set times or strength. The optimal use of polycarboxylate admixtures in day-to-day ready mix production still requires a comprehensive quality control program to ensure consistency and performance. For this reason, it is important that the admixture supplier be able to work closely on a technical support basis with the ready mix supplier to realize the performance and economic benefits that the polycarboxylic technology can provide.

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At the recent APRMCA AGM in Corner Brook, NL, incoming president Bob McGinn sang the praises of outgoing president Allan Heffell, prior to presenting him with a plaque of appreciation for the work he did during his two-year term. Hon. Kathy Dunderdale (left), Minister of Innovation, Trade & Rural Development, was the keynote speaker at the presidents' banquet. Derek Durdle (right) co-chaired the AGM with McGinn. ~ *Photo Contributed*