MCC OPTIMUM DURABILITY STUDY

INSPIRATION FADES/PERSISTENCE STAYS

Five years ago, The Minnesota Concrete Council (MCC) was inspired to establish the optimum mixture for concrete durability using recyclable by-products. Due to a persistent effort by the members and the local concrete industry, we finally have arrived at some conclusive results.

The key ingredient to success was the involvement of the ready mix suppliers; Aggregate Industries, Apple Valley Ready Mix, and Cemstone. The concrete supplier's ability to reproduce the parameters experienced in the initial laboratory study was critical. In the laboratory we mixed 3 cubic feet per batch in a controlled environment. Out there in the "real world" the ready mix suppliers mixed 243 cubic feet (9 yards) per truck. It takes much less effort and coordination to produce a meaningful concrete in the lab than in the field.

The original laboratory work (Phase I) was designed to explore the durability of 19 concrete mixes. All concretes were produced at a .40 water cementitious ratio with 5.0-7.0% air. The total cementitious amount was 658 pounds per yard. Various combinations of micro silica, slag, and fly ash were utilized.

In addition to typical plastic concrete tests, set times were measured. Compressive strengths were also determined at 1, 2, 7, and 28 days. The durability testing consisted of Rapid Chloride Permeability Test (ASTM:C1202), Drying Shrinkage (ASTM:C157), and Scaling Resistance (ASTM:C67).

The laboratory results were presented by MCC members at both the University of Minnesota's 57th Annual Concrete Conference and at the International Sustainable Construction Materials and Technologies Conference held in England in 2007. A review of the Phase I laboratory work resulted in MCC narrowing down our focus to 9 mix designs.

The original intent of the MCC was to conduct a comprehensive study which would prepare us for the increase use of recyclable by-products. There is one word that has emerged in the last five years that proves that our original intent was appropriate. That word is "sustainability." Another aspect that was discussed back in 2005 was that we wanted to actually have these mixes produced, placed, finished, and subjected to "real world" conditions.

In May and September of 2006 we had the ready mix producers deliver concrete to JATC Local 633 facility in New Brighton, Minnesota. The success of this Phase II study was mixed. Our plastic test results and durability testing were not consistent enough to publish. Subsequent petrographic work revealed the percentages of recyclable material varied from the design, thus affecting the test results.

Our inspiration faded a bit, but our persistence stayed. We needed Phase III to be more successful than Phase II. The changes we implemented were to have the batch plants batch a total of 9 yards per mix. The ready mix supplier did an excellent job of dialing in the mix the day before the Phase III study.

On May 28, 2009 we were successful in producing, placing, finishing, and testing the nine chosen mixes. The results of the Phase III portion of the study will be presented at the annual MCC Conference in February 2010.

Recyclable by-products have been used as cementitious material for the past four decades in our area. Originally, the use of lignite fly ash as a partial replacement for Portland cement was a result of finding a use for a waste product. The turn of the century has coincided with the emergence of a new philosophy with regard to the use of cementitious materials. This philosophy, based on the purposeful reuse of waste stream materials, embraces incorporating various combinations of cement, granulated slag, fly ash, and micro silica in the production of concrete. In light of environmental controls on the production of cement, shortages of suitable source materials and an ever-growing worldwide demand for concrete, MCC believes this new approach is here to stay. The intent of this study was to understand the effect each of these cementitious materials has on concrete durability. The Establishing Optimum Mixture Proportions for Concrete Durability has been a result of an inspired persistent effort by the MCC and the local concrete industry.