The Role of Chemistry in Materials Verification and Troubleshooting

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For years our industry has been working with concrete mixes that are beyond straight cement mixes.

Concrete mixes have become more complex. Process additions in cement manufacture in addition to cement replacement in concrete by supplemental cementitious materials like coal fly ash, ground granulated blast furnace slag, natural pozzolans and others reduce the cement content in today's mixes. A variety of available admixtures can enhance mix rheology, cohesiveness, air content and many other characteristic as needed. This is welcome news for the environment by reducing our carbon footprint during cement manufacture and by diverting 'waste' products away from landfills. If the mix resulted in a concrete that was easily placed, sets and gains strength normally and is durable it was considered a good mix.

Concrete troubleshooting of these multi-component mixes at first encountered complaints of workers being unfamiliar with fresh concrete that seemed to be relatively stickier to finish, set slower or faster, released less bleed water. Hardened concretes appeared to be more sensitive to discoloration problems or developed relatively lower early-age strengths.

Frequently these problems can be addressed by reestablishing good workmanship practices in mixing, placing, consolidating, finishing and curing. Yet in some instances despite good practice problems still occurred like strength development issues, discoloration, increased uncontrolled cracking, detrimental chemical reactions and others.

Concrete mix designs are typically developed in the laboratory, but occasionally similar performance does not translate to the field. Causes might include changes in proportions due to batching errors, extended mixing durations and mixing action, placement at elevated temperatures, or subsequent non-uniformity of materials. Can these problems be prevented or at least identified and corrected?

Engineers benefit from working with chemists to identify potential materials combinations that might be problematic through the use of x-ray fluorescence and diffraction. This could be in screening submitted materials or by examining hardened concrete for the cause of premature distress or loss of durability.

These complex mixes will require more collaboration between chemists, concrete technologists and engineers as society demands more from our materials, their durability and sustainability.