Restrained Shrinkage Induced Early-Age Cracking of Blended-Cement Based Concrete with Fly Ash, GGBS or Calcined Clay

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Abstract:

Restraint to early age shrinkage may cause excessive cracking in immature concrete. This can significantly affect reinforced concrete structure durability by facilitating the penetration of deleterious substances such as chlorides. Therefore, the estimation of the cracking potential of concrete is imperative to properly assess the service life of concrete elements. Shrinkage varies based on the binder composition, influencing early-age cracking. Despite the increasing demand in using supplementary cementitious materials in concrete, the effect of the binder composition on early age re-strained shrinkage induced cracking has not been fully understood.

In this study, early-age restrained shrinkage induced cracking is investigated using the restrained ring test. In total 21 concrete mixes (compressive strength ranging between 25 MPa to 100 MPa) were tested. The binder composition for each concrete grade included a reference 100% general purpose cement and blended cements with 30% fly ash, 40% or 60% slag or LC3. The results showed that increasing in concrete compressive strength is leading to a reduction in time to cracking regardless of the binder composition. Overall, fly ash is beneficial leading to a significant increase in time to cracking. Slag however contributed to decrease the cracking time. For LC3 system, concrete early age cracking greatly depends on the calcined clay reactivity.

Keywords:

Concrete, shrinkage, ring test, cracking, fly ash, slag, calcined clay.