ABSTRACT

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This thesis summarizes the results of the investigation of the parameters that may lead to workability problems, early age hydration irregularities and difficulties in achieving quality air void system in both plain and fly ash cementitious mixtures. The present research work was performed in three major phases and the statistical modeling was used to aid in data interpretation.

Phase I involved evaluation of more than 100 different paste and mortar mixtures with respect to potential slump loss and hydration irregularities. The results showed that cements with high C_3A and low SO_3 content were more prone to incompatibility problems. It was also observed that mixes with lignin based water reducer had higher tendency for rapid stiffening than mixes with poly-carboxylate type super-plasticizer (PCSP). Increased replacement of cement by class C ashes resulted in the development of abnormal secondary peaks in semi-adiabatic calorimetry curves and accelerated the setting behavior.

The focus of phase II was on identifying material combinations that can result in problems related to air void generation and stability. The experiments were conducted on 18 different systems and included determination of foam drainage and foam index parameters. The results show that the amount of air entrainers required to obtain target air percentage, increased with the increase in the fly ash content in the mixture. Lignin based WR had, in general, a higher air entraining effect than the super-plasticizer when used in combination with air entrainers. Also, five out of the six mixtures with most unstable air void system, identified using the foam drainage experiments, contained the PCSP.

The third (and final) phase of the study involved production of 10 concrete mixtures to verify the incompatibility findings from the paste and mortar experiments performed in phases I and II. The observations from the concrete testing were in agreement with the findings from the paste and mortar testing.

Statistical modeling (performed using the material properties and results from phase I) identified the total C_3A, SO_3 and Na_2O_{equ} contents of the binder system along with presence of PCSP (if present in the mixture) as statistically significant in predicting the initial set time and area of spread measured at different time using the mini-slump test.

Key words: Materials incompatibility, early age stiffening, set time and hydration irregularities, admixtures, mini-slump, foam drainage, semi-adiabatic calorimetry, statistical modeling.