HYDRATION AND STRENGTH DEVELOPMENT OF BLENDED CEMENTITIOUS SYSTEMS MIXED WITH SEAWATER

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Water and concrete are the first and second most consumed materials in the world. Water shortages are being reported across the world and an acute shortage of freshwater is expected in 17 countries by 2040. Alternative water sources for producing concrete to reduce freshwater consumption is being restricted by maximum limits on total solids and chlorides content by several international standards for concrete production such as EN 206, ACI 318, and IS456. However, in the recent years it is suggested that seawater-mixed concrete could be an alternative to the conventional concrete for niche applications in certain regions of the world with severe water shortage. Also, more research on long-term durability of these seawater-mixed concretes is necessary to adapt changes in codes and specifications for making concrete.

The present work focuses on understanding the acceleration effect of seawater mixing in concrete made with ternary blended cementitious systems containing ground granulated blast furnace slag, and metakaolin (PS20M10 & PS40M20). CEM I 42.5R (PC) cement was used to prepare cement paste specimens with water-to-cement ratio of 0.4. Among the six mixes in this study, three mixes were cast with freshwater (FW) and three mixes with artificial seawater (SW) prepared conforming to ASTM D1141. Paste specimens were cast and compressive strength at 2, 7, 14, and 28 days were measured. In addition, the cumulative heat of hydration for 7 days was determined in cement paste specimens using isothermal calorimeter.

Fig. 1 shows the evolution of % change in compressive strength (SW/FW) of cement paste specimens made with CEM I and CEM I blended with slag and metakaolin. The cementitious systems with slag and metakaolin showed a higher improvement in the strength even at 28 days contrasting to the performance of PC mixes that had better performance at an early age (< 7 days).

Fig 2. shows the reduction in final setting time in SW mixes calculated from the calorimetry results. Setting time is defined as the time taken for silicate peak/end of acceleration period from calorimetry results. A significant reduction in the setting time was observed in OPC and blended cementitious systems containing SW. Despite having very high replacement levels (60% in PS40M20 mix), the ternary blended cementitious systems also showed a significant reduction in setting time. These results demonstrate the feasibility of using seawater as mixing water for concretes produced with both Portland cement and blended cement systems. The presence of slag and metakaolin can enhance the chloride-binding and ensure an improved durability of cementitious systems.

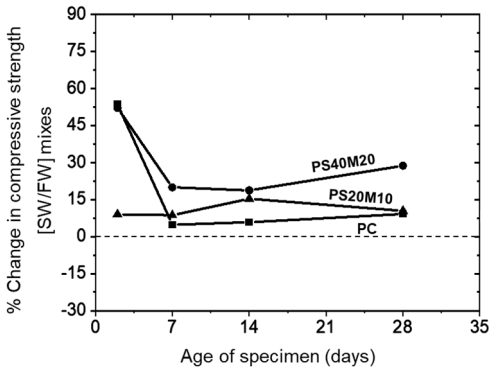

Fig. 1: Evolution of compressive strength in cement pastes between 1 and 28 days of moist-curing.

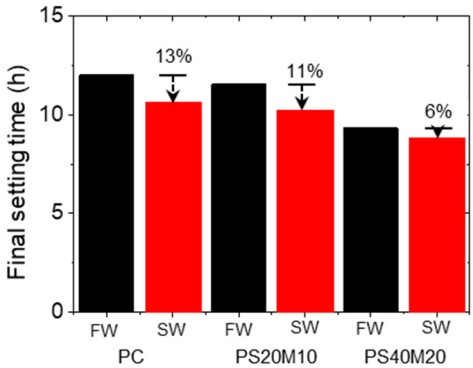

Fig. 2: Calculated setting time based on calorimetry results

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