Influence of temperature and time on the properties of fresh cement-based self-compacting concrete

The rheological properties and thus workability of fresh self-compacting concrete (SCC) can be described by yield stress and plastic viscosity. One of the key technological factors affecting workability of SCC is temperature. Recent studies on the SCC have shown that as the temperature increases, the yield stress decreases and therefore workability improves. Over the time, we can observe the opposite effect, as the temperature increases, the yield stress decreases. However, this relationship may differ when using different configurations of mineral additives. The aim of the research was to find the correlation between temperature and rheological properties of normal and high-strength SCC for with high-calcium fly ash (CFA), finely ground limestone (LL) and other mineral additives such as Ground Granulated Blast Furnace (GGBS) or silica fume. It was found that the impact of the temperature on the rheological properties in time can be minimised by using mineral additives. Up to 30% of clinker replacement with CFA does not strengthen the impact of temperature on workability. Replacing the CFA by LL or GGBS in a mass ratio 1:1 allows to increase the stability of rheological properties to temperature change. This does not apply to when using both silica fume and LL as more than 30% clinker replacement. Fresh SCC concrete loses its self-compacting properties. In this case, as the temperature increases, workability decreases. The type of chemical admixture and w/c ratio also affects quantitatively and sometimes qualitatively on the changes of rheological parameters of SCC under different temperature. It is, however, difficult to draw general conclusions on the effect of temperature on the rheological properties of SCC. In this work also examined the influence of rheological properties of SCC on the formwork pressure. The temperature influences the flowability and thus can affect the formwork pressure. It was found that the formwork pressure decreases with the increase of the yield strength. Combining this with the effect of temperature on the SCC yield stress, it can conclude that as the temperature increases, the formwork pressure increases. After casting, but before concrete setting, the SCC formwork pressure decreases as the effect of reversible concrete structure build up. The concrete structure allows to transfer the self-weight of the concrete, which reduces the formwowk pressure. The rheological parameter describing this phenomena is static yield stress (gs). It increases with time and with increasing temperature reaching higher values for SCC with higher w/c. There are many factors that affect the workability of fresh SCC, such as composition change, w/c, temperature and other technological factors. Designing SCC is time-consuming and labour-intensive, therefore attempts are made to use cement based mortars to increase efficiency of designing of SCC mixes. This study showed that there is clear correlation between yield stress and plastic viscosity, and for a first time static yield stress (gs) and thixotropic stiffening index (At), for cement mortars and fresh SCC. This make less labour and cost intensive mortars can be used to predict the rheological properties of fresh SCC. This study demonstrates for the first time that static yield stress and thixotropic stiffening index AT can be used to predict the SCC formwork pressure. This may allow SCC mixes to be designed to reduce formwork pressure.

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