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Sensitivity Analysis of the Thermal Properties in Early Age Modeling of Mass Concrete

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Abstract : In many civil engineering applications, especially in the construction of large concrete structures, the early age behavior of concrete has shown to be a crucial problem. The uneven rise in temperature within the concrete in these constructions is the fundamental issue for quality control. Therefore, developing accurate and fast temperature prediction models is essential. The thermal properties of concrete fluctuate over time as it hardens, but taking into account all of these fluctuations makes numerical models more complex. Experimental measurement of the thermal properties at the laboratory conditions also can not accurately predict the variance of these properties at site conditions. Therefore, specific heat capacity and the heat conductivity coefficient are two variables that are considered constant values in many of the models previously recommended. The proposed equations demonstrate that these two quantities are linearly decreasing as cement hydrates, and their value are related to the degree of hydration. The effects of changing the thermal conductivity and specific heat capacity values on the maximum temperature and the time it takes for concrete to reach that temperature are examined in this study using numerical sensibility analysis, and the results are compared to models that take a fixed value for these two thermal properties. The current study is conducted in 7 different mix designs of concrete with varying amounts of supplementary cementitious materials (fly ash and ground granulated blast furnace slag). It is concluded that the maximum temperature will not change as a result of the constant conductivity coefficient, but variable specific heat capacity must be taken into account, also about duration when a concrete's central node reaches its max value again variable specific heat capacity can have a considerable effect on the final result. Also, the usage of GGBFS has more influence compared to fly ash.

Keywords : early-age concrete, mass concrete, specific heat capacity, thermal conductivity coefficient
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