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An Experimental Study on the Thermal Properties of Concrete Aggregates in Relation to Their Mineral Composition

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Abstract : The analysis of the petrologic characteristics and thermal properties of crushed aggregates for concrete such as granite, gneiss, dolomite, shale and andesite found that rock-forming minerals decided the thermal properties of the aggregates. The thermal expansion coefficients of aggregates containing lots of quartz increased rapidly at 573 degrees due to quartz transition. The mass of aggregate containing carbonate minerals decreased rapidly at 750 degrees due to decarboxylation, while its specific heat capacity increased relatively. The mass of aggregates containing hydrated silicate minerals decreased more significantly, and their specific heat capacities were greater when compared with aggregates containing feldspar or quartz. It is deduced that the hydroxyl group (OH) in hydrated silicate dissolved as its bond became loose at high temperatures. Aggregates containing mafic minerals turned red at high temperatures due to oxidation response. Moreover, the comparison of cooling methods showed that rapid cooling using water resulted in more reduction in aggregate mass than slow cooling at room temperatures. In order to observe the fire resistance performance of concrete composed of the identical but coarse aggregate, mass loss and compressive strength reduction factor at 200, 400, 600 and 800 degrees were measured. It was found from the analysis of granite and gneiss that the difference in thermal expansion coefficients between cement paste and aggregates caused by quartz transit at 573 degrees resulted in thermal stress inside the concrete and thus triggered concrete cracking. The ferromagnesian hydrated silicate in andesite and shale caused greater reduction in both initial stiffness and mass compared with other aggregates. However, the thermal expansion coefficient of andesite and shale was similar to that of cement paste. Since they were low in thermal conductivity and high in specific heat capacity, concrete cracking was relatively less severe. Being slow in heat transfer, they were judged to be materials of high heat capacity.

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