TG and DSC Analysis of Blended Binder Based on Waste Ceramic Powder and Portland Cement

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The cement production has high negative impact on the quality of environment, and its sustainability is open question for material researchers and producers. Worldwide, the cement industry alone is estimated to be responsible for about 7% of all CO2 generated. Additionally, the cement production requires high energy impact, which is approximately 850 kcal per kg of clinker. To ensure the future competitiveness of concrete as a building material, it is essential to improve the sustainability of concrete structures. Therefore, the replacement of cement in concrete by any type of industrial waste represents a tremendous saving of energy and has important environmental benefits. In this paper, possible usage of waste ceramic powder in blended binder is studied. At first, chemical composition of Portland cement and ceramic powder is accessed using XRD. The fineness of ceramics milling is characterized by specific surface and particle size distribution measurement. The pozzolanic activity and the hydration process of the blended binder with ceramics amount varying from 0 to 40 mass% of the cement is researched using the differential scanning calorimetry (DSC) and thermogravimetry (TG). The DSC and TG measurements are done for 2, 7, and 28 days wet cured samples in order to monitor the rate of hydration. The investigation is performed in an argon atmosphere in the temperature range from 25 °C to 1 000 °C with a rate of 5 °C/min. The obtained results show changes in the chemical composition of the studied blended binder at high temperatures, and document the pozzolanic activity of applied ceramics. The temperature and enthalpy of the C-S-H dehydration, portlandite and calcite decomposition are distinguished, and the changes of portlandite amount are accessed in dependence on time of hydration.