The aim of the dissertation is the possibility of effective using plastic waste as an alternative aggregate in cementitious composites. Due to globally ineffective plastic waste disposal some countries already apply plastic waste as a substitution of natural aggregate, although it decreases mechanical parameters of composites such as compressive strength.

In a first phase of the research the type of artificial aggregate was chosen from plastics like HDPE, PET, PVC. PET in a form of flakes was taken under consideration for the following research. Further the optimum fraction of plastic waste aggregate was selected. Natural aggregate was replaced by 2%, 5% and 10% volume of alternative aggregate.

Poor bonding between phases of cement matrix and flat surface of PET flakes in composites can be the reason of decreasing mechanical parameters of mortars. In order to improve the structure of interfacial transition zone in mortars, mechanical and chemical modification of PET surface was applied. The chemical modification consisted of immersing plastic waste aggregate in different solutions for different periods of time. Mechanical modification consisted of mixing PET flakes in cylindrical container in a presence of steel balls and powdered material like quartz, lime and cement. Due to unsatisfactory results unmodified PET flakes were used in following research.

Afterwards impact resistance, freeze-thaw resistance and chloride ion penetration tests were conducted in order to determine PET wastes as an applicable alternative aggregate in cement composites. Unlike compressive strength, the impact resistance improved after adding PET flakes. Moreover, addition of plastic waste aggregate did not affect chloride ion penetration and freeze-thaw resistance.

During international internship the range of research was extended by including alkali activated materials, where the main binder was metakaolin. At the beginning metakaolin partially substituted cement in composites, then attempt to completely replace cement was made by changing dosage of activators. Furthermore, ground granulated blast furnace slag was included in the research as a second type of alternative binder to compare parameters of mortars cured in different conditions, with different amount of activator and PET flakes. Samples cured in 40°C presented improvement of mechanical strength after adding plastic waste aggregate. Furthermore, Scanning Electron Microscope analysis was performed.

Although compressive strength of mortars decreased after adding plastic waste aggregate, the application of that kind of alternative aggregate is still potentially possible in construction industry, due to positive results of impact resistance, freeze-thaw resistance and chloride ion penetration tests. The thesis of possible application of plastic waste PET flakes as an alternative aggregate in cementitious composites was confirmed, although attempts to improve compressive strength of composites was unsuccessful.

Agnieszka Kocot, 11.09.2023 r.

* wyłączenie jawności w zakresie danych osobowych oraz prywatności osoby fizycznej na podstawie art. 5 ust. 2 ustawy z dnia 6 września 2001 r. o dostępie do informacji publicznej (tj. Dz. U. z 2026 r. poz. 1764)

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