SUMMARY

Analysis of rheological properties of cement composites based on waste materials

Waste management is an important problem analyzed by scientists. Changing regulations force production companies to look for opportunities to manage waste generated in factories. In this dissertation, an extensive analysis of the possibility of using several waste materials in order to create cement composites with properties corresponding to traditional concretes has been carried out. Wastes from the production of ceramic hollow bricks, wastes from the production of porcelain products, waste sand obtained in the process of aggregate hydroclassification in opencast mines located in north-western Poland were analysed. These wastes were used as substitutes for natural aggregate. In addition, steel cord obtained in the recycling process of used car tires was used as a dispersed reinforcement of the composites. Commercial steel hooked fibres were also used for comparison purposes. The research was divided into four research tasks. In the first task, the basic properties of selected waste materials were determined. among others the apparent density, voids and absorbability of aggregates prepared from factory waste were determined, the tensile strength of the steel cord and the effect of bidirectional bending on the strength of the fibres were determined. In the second stage, the possibility of using steel cord as dispersed reinforcement was determined. Elements with a fibre content of 0.25% were analysed; 0.50%, 0.75%, 1.00%, 1.25%, 1.50%. The tests were carried out on beams of cement mortar with dimensions of 40x40x160 mm. To determine the properties of mortars reinforced with steel cord, a three-point bending test was performed based on the PN-EN 196-1 standard, additionally measuring deflection under load during strength tests. The conducted analyzes made it possible to determine the recipes of cement composites based on waste materials. A total of 24 mixes were prepared, in which various amounts of waste aggregates were used. Samples with 0.0%, 0.5% and 1.0% fibre amounts were prepared for each blend. In the third task, a number of tests were carried out to determine the temporary and rheological strength properties of selected cement composites based on waste materials. Compressive strength, modulus of elasticity, residual strengths were determined, and shrinkage and creep were determined for selected composites. The above-mentioned tests were carried out on the basis of standard guidelines. The fourth task was to determine the rheological properties of selected composites based on long-term tests of beams with dimensions of 100x200x2900mm. For the purposes of the tests, a test stand was designed to enable simultaneous testing of three beams. In addition to traditional measurement methods, an optical system was used to measure beam surface deformations and cracks. The tests were carried out at eight positions. A single station consisted of three beams made of the same composite, with different amounts of dispersed reinforcement. The conducted research showed that composites with properties similar to traditional concretes can be produced from the tested waste materials. In addition, after analysing the results of rheological properties, a correction factor was proposed for the method of calculating the crack width included in the PN EN 1992-1-1 standard.