POPULAR SUMMARY OF THE PROJECT

In view of the intensive development of the construction industry and the importance of environmental concerns, in recent years attention has increasingly been paid to the design and fabrication of construction materials that will exhibit not only adequate strength and quality parameters, but also low carbon and water footprints and high durability causing a longer life cycle, which together will lead to the creation of sustainable products. Unfortunately, the production of many construction materials, including concrete in particular, is associated with high atmospheric CO_2 emissions and significant energy inputs, which in the case of concrete are required for its production and its incorporation into construction elements. Materials which may be used to mitigate the environmental impact of concrete include chemical admixtures, especially superplasticizers, which when added even in small quantities can enable significant reductions in quantities of cement and water, while retaining the suitable rheological parameters of the mixture. Reduction of the water–cement ratio also leads to improvement in the compression strength of cement composite, and the replacement of clinker in the structure of concrete with alumino-silicates compounds having pozzolanic and/or hydraulic properties also leads to improvement of the materials' performance and durability. Unfortunately, the need to supplement cement clinker with ever increasing quantities of additives sometimes results in a lack of compatibility with new cements containing superplasticizers, leading to their partial or total deactivation.

The answer to the above-described problems proposed in this project is theuse of task-specific functional ionic compounds with tunable properties as chemical admixtures modifying the rheological and antibacterial properties and durability of cement composite. The application of ionic compounds will also lead to improved compatibility between modern cement binders containing supplementary cementitious materials and the commonly used polycarboxylate ether's superplasticizers (PCE). Another important element of the research will be the use of ionic compounds for the design of an innovative complex admixture based on polycarboxylate derivatives, which can be expected to exhibit greater affinity to the new cement binders than the widely available typical PCE superplasticizers. This will undoubtedly contribute to the obtaining of a durable and sustainable cement matrix. A further goal of introducing ionic fragments into the structure of the superplasticizer is dictated by additional antibacterial properties, through the use of anions based on coordinated metal salts.

The complex admixtures produced under the project will enable elimination of the currently commonly encountered problems with the workability of cement composites produced using modern cement binders with additives, especially the loss of dispersive action in the case of the latest generation of superplasticizers. To solve these problems, it is planned to carry out comprehensive testing of fresh mixtures made using cements in which the clinker is partially replaced with additives having pozzolanic and hydraulic properties, including the latest additives from the categories of calcined clays and limestone-calcined clays. Tests to determine how the produced materials affect the electrokinetic properties, the heat of hydration of binders, plasticity, and viscosity, which will facilitate the correct design of ionic admixtures and the obtaining of the best possible compatibility with new cement binders will be carried out. At the second stage, a wide range of tests will be performed on the composites after setting, including mechanical, structural and durability tests. For selected ionic compounds with bactericidal properties, detailed antibacterial tests will be conducted to examine their ability to inhibit the growth of selected Gram-positive and Gram-negative bacteria, as well as fungi. A further key element of the project are aging tests, which will enable determination of the resistance of the materials to long-term atmospheric effects.

A result of the project will be the development of functional cement composites containing as admixtures sustainable ionic-based compounds with defined, strictly controlled properties. The newly designed cement composites may contribute significantly to the development of sustainable construction, reducing the production costs of construction materials, due to the use of relatively cheap components that allow the materials to retain optimal functional properties. The project will also result in publications in renowned scientific journals with high impact factors (including *Composites Part A* and *B*, *Cement and Concrete Composites*, *Construction and Building Materials*, etc.), as well as appearances at national and international conferences, at which the results of the work will be presented. The research planned under the project will be carried out in cooperation by two independent research teams at Poznan University of Technology and the Silesian University of Technology. The complementary of human and laboratory resources available at the two centers will guarantee the competent and timely completion of the work to the highest scientific standards.