Effect of the molecular weight and architecture of hyperbranched polyglycerol on its performance as superplasticizer in cementitious system

Concrete is a composite material in which aggregates (gravel and sand) are bound by hydrated cement paste. The amount of water required for the reaction of hydration represents about 25% of the mass of cement. However, in order to obtain flowing concrete, which can be either cast or pumped, much more water is required (about double). In the long term, this excess water evaporates, leaving voids in the concrete. The associated porosity decreases both the mechanical strength and durability. Such concrete does not reach the optimal properties it could have if it was produced as a more compact material. This is where water reducing admixtures are of interest.

Superplasticizers are polymeric dispersants, which when added in small amounts to concrete (typically less than 0.5% of the mass of cement), allow high water reduction for the same workability. As soon as the superplasticizers are in contact with cement particles, some of them are adsorbed on the cement particles and create negatively charged particles, repulsing each other so that the cement particles no longer flocculate. The most commonly used water reducing admixtures for concrete are lignosulfonates and polycarboxylates.

Hyperbranched polymers represent a new class of polymeric compounds which attracts attention of many research groups. Because of their unique features such as high solubility, low viscosity, high concentration of reactive groups they find many applications in chemistry and material sciences. The purpose of this project is to investigate the influence of a hyperbranched polyglycerols with different architectures (structural and chemical modification) on the selected properties of cement paste, mortar and concrete.

The research project will bring new knowledge about the features of the hyperbranched polymers and the methods of shaping its properties on the nano-level towards the favourable cooperation with the mineral particles, for example the cement ones. The results of the project will make possible the deeper understanding of the nature of the interaction of the hyperbranched polymers with various environments, including the cement pastes of various compositions. This work is not only helpful for understanding the relationship of molecular structure of hyperbranched polyglycerol and their performance, but also further designing optimum molecular structure of polyglycerol to meet the requirement in concrete system. The obtained results will be compared with the results gathered by other researchers for the other chemical compounds, which are described in the scientific publications. From the social point of view, the project will lead to the new ways of use of by-product – glycerol, thus supporting the rules of the sustainable development.

The primary objective of this study is to evaluate the effect of architecture and molecular weight of hyperbranched polyglycerol on the selected properties of cement-matrix composites (like cement paste, mortar and concrete). The experimental investigation will be carried out in two phases. In phase 1, synthesis of the hyperbranched polyglycerol with different number average molecular weight (M_n). The phase 2 investigate the influence of polymers on dispersion, adsorption, hydration, and mechanical properties of a cementitious system.