Application of pH-sensitive hydrogels for concrete applications

A. Mignon [1-2], D. Snoeck [1], S. Van Vlierberghe [2], P. Dubruel [2] and N. De Belie [1]

1) *Magnel Laboratory for Concrete Research, Ghent University, Belgium*
2) Polymer Chemistry and Biomaterials Group, Ghent University, Belgium

Arn.Mignon@ugent.be, Nele.DeBelie@ugent.be

Abstract

The biggest problem in concrete are cracks occurring due to the relatively low tensile strength. These cracks can generate an entrance for harmful compounds which are dissolved in fluids and gases and endanger the durability of concrete. The cost for crack repair is very high. Instead, inserting a polymer during concrete mixing can create a crack-sealing material. Using a hydrogel will help to heal cracks as soon as they occur, without any external interference.
Fresh cement pore solution has a pH value of 12.8, but when a crack occurs, the pH lowers to 9 - 10 or even lower according to the environment of the application. At this lower pH value, the swelling degree of the inserted hydrogel must be high enough to fill up the crack. A swelling capacity curve was made over the entire pH-range (pH 1-13). The hydrogel gave a high swelling degree at the wanted pH values and may therefore be useful to use in concrete. The added amount of hydrogel was chosen at 0.5 and 1 m%.
Water permeability and flexural and compressive strength tests were then performed. The significant decrease in water permeability of hydrogel containing cracked concrete relative to cracked reference concrete is a quantitative indication of the sealing capacity of the used hydrogel.
The uptake of mixing water by the hydrogel will reduce the effective water/cement ratio of the cementitious matrix. This water will be released later-on and will cause internal curing. A higher added amount of the polymer will cause a better healing capacity and a higher uptake of water during the mixing process. More tests were performed using additional mixing water. This resulted in a higher apparent water/cement factor during internal curing and, together with macro pore formation, in a lower strength.
This new polymer appears to be promising to introduce a crack-sealing potential in concrete.