Control of polymorphism of calcium carbonate compounds in the cementitious materials by pH control

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Generally, cracking is inherent in reinforced concrete structures and leads to serious damage during its service period. Repeated occurrence of such damages will lead to the enlargement of the cracks, thereby allowing other deteriorating elements such as CO₂ and Cl⁻ to further penetrate the concrete, and this can have serious consequences for the concrete structure. On the other hand, in an environment where there is supply of water, concrete structures display "self-healing," in which some of cracks close up naturally, and this phenomenon is closely associated with the hydrates that are newly generated in the areas of crack formation. This study focuses on the type of CaCO₃ crystals generated by the self-healing phenomenon. CaCO₃ is crystal polymorphism and it is reported that crystal forms can be controlled by the relationship of temperature and pH. Generally, CaCO₃ consists of the three kinds, such as calcite, vaterite and aragonite for crystal formation. On the other hand, vaterite is also generated most densely among these, and self-healing can be expected. Therefore, an experiment is made for the purpose of establishing the conditions to generate vaterite. The supplied saturated Ca(OH)₂ solution is used for the effective self-healing. Conditions of the pH are managed pH 9.0-12.0. The results showed that self-healing occurred and the product of the self-healing phenomenon was mostly vaterite to a crystal of CaCO₃ under the condition of pH 9.0. Finally, if we can develop crack resistant concrete or methods for controlling cracks and self-heal cracked concrete, concrete would last longer and become a more sustainable construction material than the standard concrete. This would extend the life of concrete structures and hence potentially lower human CO₂ emissions through improving concrete durability. That is, it is expected that self-healing of concrete can facilitate the maintenance and management of concrete structures, reduce environmental loads, and extend the lifespan of concrete structures.

Figure: The self-healing mechanism of concrete.

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Biography
Heesup Choi has his expertise in evaluation and passion for improving the self-healing of concrete. He has built this technique after years of experience in research, evaluation, teaching and administration both at Tokyo University and Kitami Institute of Technology of Japan. The foundation is based on autogenous healing of concrete which is a methodology of water permeability and autogenous healing of cracks in concrete. It allows for prevention of micro crack by various degradation of concrete.

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