CO_2 utilization and sequestration: Investigation of multiple-time-recycled construction waste powder modified by carbonation as a partial replacement for cement

Considering the meaning of sustainable development, recycling should be both repeatable and environmentally friendly. Under these principles, recent research is moving beyond the single-use recycling of construction waste towards multiple-time recycling. However, despite being a crucial element in achieving the zero-waste goal for construction waste and reducing the negative environmental impact, the utilization of fine powder/dust generated unavoidably during the repeated recycling process of construction waste remains a challenging task.

As recycled construction powder is recycled repeatedly, the particles have more microcracks and micropores, which has an unfavorable effect on the performance of cementitious materials when used as a partial replacement for cement. Therefore, appropriate modification is required for its effective utilization. Various methods have been proposed for the modification of recycled construction powder, such as thermal activation and the addition of chemicals. However, these methods inherently possess significant energy-intensive limitations. On the other hand, the carbonation method, exposing recycled construction powder to CO_2, not only enhances the pore structure of the powder but also provides sustainable value by directly utilizing and sequestrating CO_2. In short, exposing construction waste powder to CO_2 and carbonating it offers several benefits: (i) improvement of material characteristics, (ii) utilization/sequestration of captured CO_2, and (iii) reduction in cement consumption through the use of carbonated construction waste powder as a cement replacement.

Therefore, this project seeks to achieve zero-waste and multiple-time recycling of construction waste in an eco-friendly manner by applying a carbonation method to multiple-time-recycled construction powder. Specifically, (i) carbonation exposure conditions that modify the characteristics of multiple-time-recycled construction powder are optimized; (ii) the feasibility of developing eco-friendly cement blended with carbonated multi-recycled construction powder that meets the strength requirements specified by industry standards is investigated; (iii) the economic and environmental values resulting from the application of carbonation methods are discussed.

The results derived from this research project are linked to engineering and environmental values, such as the development of alternative cements and the utilization and sequestration of captured CO_2, and will be disseminated in reputable journals and at relevant conferences.

The project is directly/indirectly related to UN's Sustainable Development Goals 9 (Industry, innovation and infrastructure), 11 (Sustainable cities and communities), 12 (Responsible consumption and production), and 13 (Climate action).