# $C^4S^*$ Research and Development Project

*$C^4S$: Calcium Carbonate Circulation System for Construction

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## Summary

Concrete is an indispensable construction material for social capital development, but its production uses a large amount of limestone and emits a large amount of $CO_2$. The estimated age of limestone is 200 years at best, and 7-8% of the world's annual $CO_2$ emissions come from cement production. To fundamentally solve the problems of resource depletion and $CO_2$ emission in conventional concrete, in this project, Ca in concrete accumulated in structures is considered as a potential unused resource that can absorb $CO_2$. The project will develop a technology to produce an innovative concrete, calcium carbonate concrete (CCC), using only concrete waste generated from the demolition of structures and $CO_2$ in the atmosphere as raw materials. CCC can be put to practical use as a major construction material to replace conventional concrete, thereby recovering a large amount of $CO_2$ from the atmosphere and creating a new resource circulation system ($C^4S$: Calcium Carbonate Circulation System for Construction) (Fig. 1).

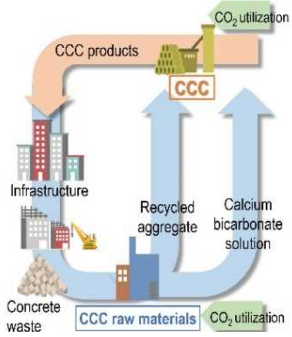

Fig.1 Resource circulation

Fig.2 Strength gain in CCC

In the production of CCC, the crushed powder is used as raw material for calcium bicarbonate solution, and the particles are filled into a container with pressure as aggregate. The calcium bicarbonate solution is impregnated into the aggregate particles, and calcium carbonate crystals are precipitated by heating and drying, bonding the aggregate particles together to form CCC. As a result of attempts to use the precipitation method, the pressurization method, and the stacked pressurization method, the optimum temperature for dissolving calcium from powder, the optimum pressure for filling of aggregate, and the optimum temperature for precipitation of calcium carbonate have been identified and compressive strengths of 56 $N/mm^2$ for a 1 cm diameter specimen and 23 $N/mm^2$ for a 10 cm diameter specimen have been obtained. Then studies on ramen structures with prestressed steel tube structures for CCC column members and wall-type structures with CCC blocks are underway. In addition, for social implementation of $C^4S$, studies are being conducted on the conformity of CCC structures to current laws and standards, optimal resource recycling scenarios based on the prediction of concrete waste generation, and low-energy CCC manufacturing methods based on the analysis of $LCCO_2$ reduction effects.

By realizing $C^4S$, global warming will be greatly suppressed, and the global environment will be regenerated, as CCC fixes a large amount of $CO_2$ in the atmosphere and can be recycled many times as a major construction material with energy conservation, just like the uplift process of the Himalayas and the Alps fixed $CO_2$ and created Cool Earth in prehistoric times.

## KPI

| FY2022 | FY2024 | FY2029 |
|---|---|---|
| CCC with compressive strength of 12 $N/mm^2$ or larger will be realized at the concrete test specimen level (cylinder with a diameter of 10 mm and a height of 20 mm). | CCC with a compressive strength of 30 $N/mm^2$ will be achieved at 10 cm diameter specimen, and CCC column members with a diameter of 15 cm or more and CCC beam members with a length of 100 cm or more with a compressive strength of 12 $N/mm^2$ or more will be continuously manufactured in a bench plant to produce a simulated two-layer structure of 2 m wide, 1 m deep and 3 m high. | Achieve CCC structural members with the same performance as conventional concrete, that is, compressive strength of 30$N/mm^2$, and start general supply of CCC low-rise buildings with seismic resistance and durability. |

## Implementation

The University of Tokyo, Hokkaido University