Toward Realizing a Circular Economy for Concrete

# "CCC" Future Concrete to Save the Earth

## ～NEDO Moonshot-style research and development project：C⁴Sproject～


TheUniversity of Tokyo • Taiheiyo Cement • Hokkaido University • Masuo Recycle • Utsunomiya University • Kogakuin University • Tokyo University of Science • Shimizu Corporation

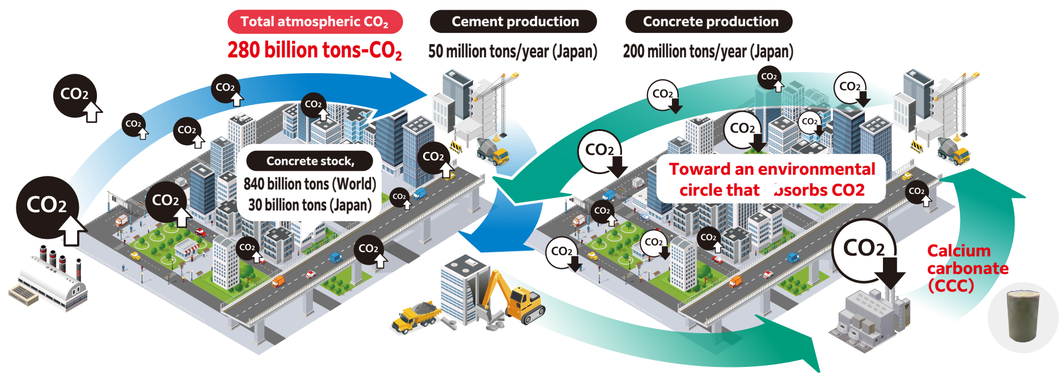
NEDO New Energy and Industrial Technology Development Organization

MOONSHOT R&D PROGRAM


## Background of the Project

To date, the calcination (decarbonation) of limestone during cement production has resulted in cumulative global $CO_2$ emissions exceeding 50 billion tons (and over 80 billion tons when including emissions from combustion energy).

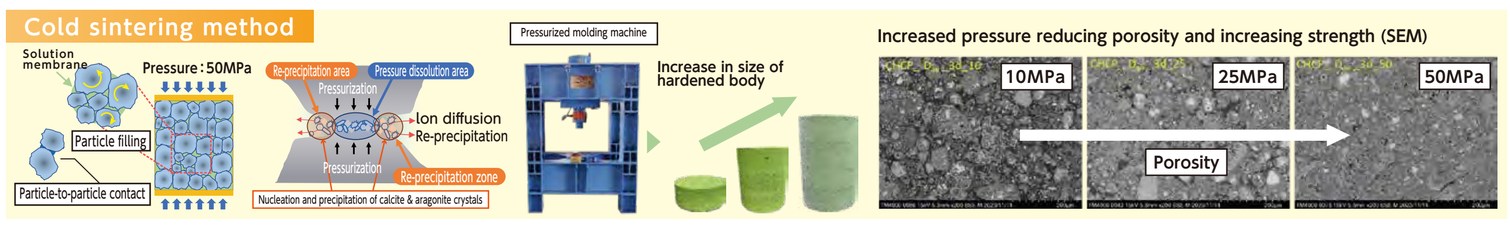
We recover all $CO_2$ emitted during cement production and accumulated in the atmosphere, converting it into calcium carbonate ($CaCO_3$).
This calcium carbonate is then used as a binding agent in calcium carbonate concrete (CCC) for structural construction. By manufacturing concrete that absorbs $CO_2$ and commercializing it as a primary construction material to replace conventional concrete, we aim to establish a new resource circulation system (C⁴S*).
*Calcium Carbonate Circulation System for Construction




## Project Overview

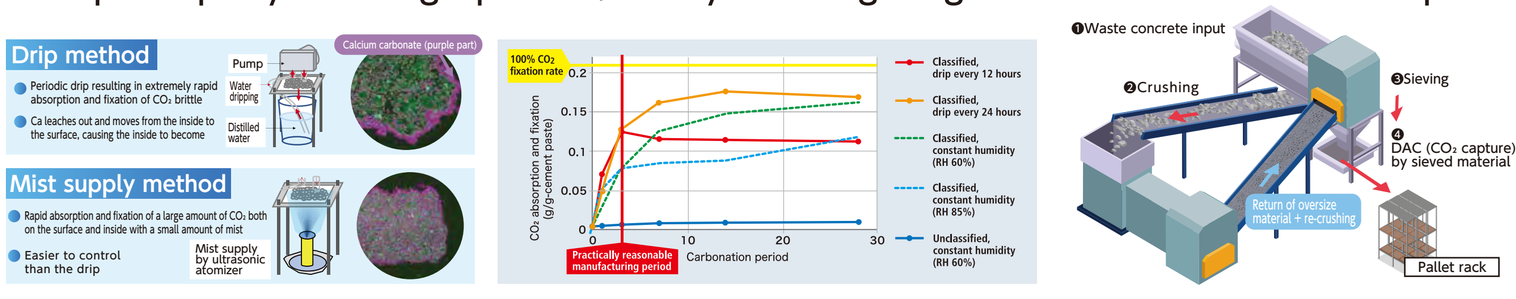
### CCC Manufacturing Method — PROJECT Ⅰ The University of Tokyo Tokyo University of Science

After the carbonated waste concrete particles are mixed with calcium bicarbonate solution, they are packed tightly in a rigid mold and pressurized to cause dissolution of calcium at the contact zone of the particles and re-precipitation of calcium carbonate crystals(calcite, aragonite), followed by several cycles of drying and immersion in calcium bicarbonate solution to produce CCC units.



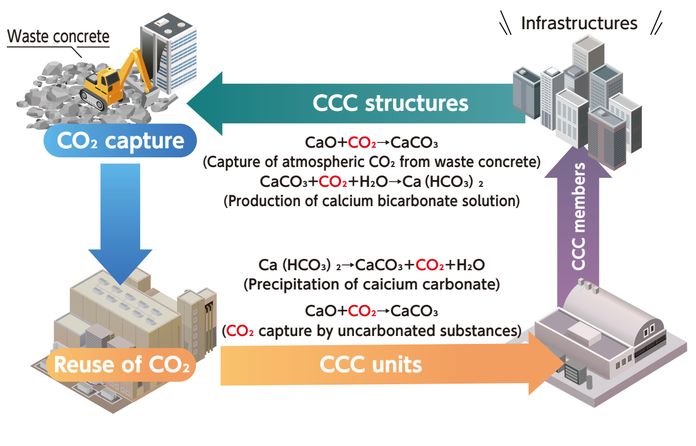

### Methods for $CO_2$ Capture — PROJECT Ⅱ Hokkaido University・Masuo Recycle

By repeatedly providing the fine particles of crushed and graded waste concrete with moderate moisture content, the calcium component (CaO) in the waste concrete reacts with carbon dioxide ($CO_2$) in the atmosphere quickly and in large quantities, thereby recovering a large amount of $CO_2$ from the atmosphere.



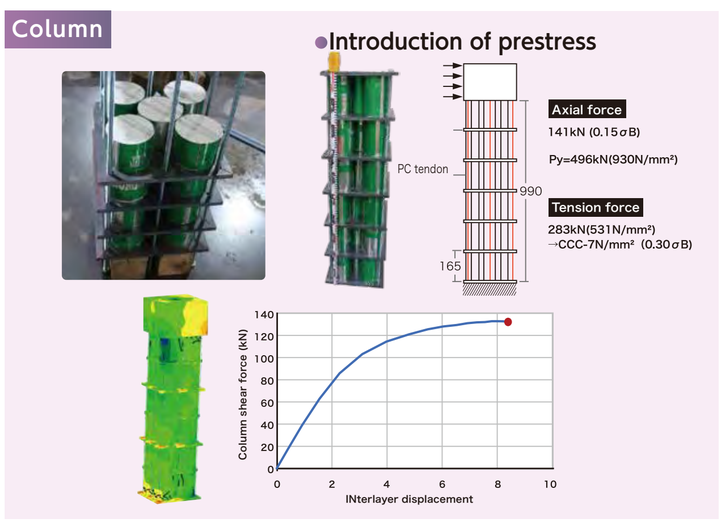

### Social Implementation of CCC — PROJECT Ⅲ The University of Tokyo・Kogakuin University・Utsunomiya University・Shimizu Corporation

Calcium carbonate concrete (CCC) is produced using only atmospheric $CO_2$ and waste concrete, which are ubiquitous raw materials. CCC is then permanently recycled as a construction material. Proposals will be made to optimize resource circulation and maximize $CO_2$ capture, which are necessary for social implementation of CCC, as well as to develop the basic criteria and standards for CCC structures.



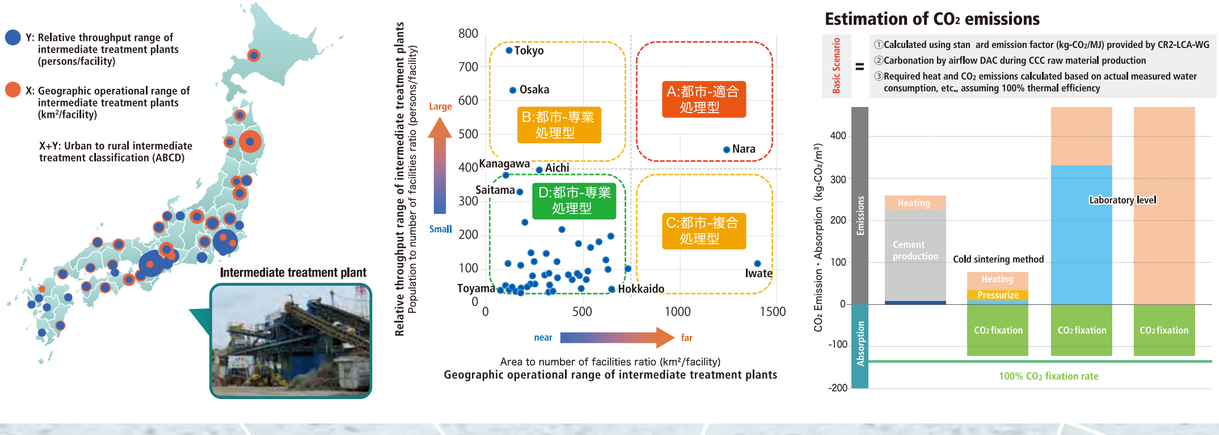

### CCC Structure — PROJECT Ⅰ・Ⅲ The University of Tokyo・Tokyo University of Science・Shimizu Corporation

Column and wall components are constructed by connecting calcium carbonate concrete (CCC) units and applying prestress to integrate them, and beam and floor components are constructed by combining them with steel, wood, FRP sheets, etc., or by using arch, vault, or dome structures where only compressive forces act, and the column, wall, beam, and floor components are then connected to form a CCC structure.




### Distribution of Intermediate Plant Facilities and Estimated $CO_2$ Emissions

In the future, as structures reach the end of their service life and are demolished, over 100 million tons of waste concrete will be generated annually, reaching a cumulative total of approximately 4 billion tons by 2050. For every 1m³ of CCC produced, over 100kg (target: 124kg) of $CO_2$ is captured from the atmosphere and sequestered.




### Project Perspective

Alter confirming that the quality of CCC and the performance of CCC structures satisfy the building code, we aim to construct several CCC buildings in 2030 and half of all concrete structures in 2050 will be CCC structures.

| Fiscal year | Development and dissemination of CCC | CCC production volume |
|---|---|---|
| 2023 | Compressive strength of 12 MPa achieved | 0 thousand tons |
| 2024 | Construction of experimental structures | 0.1 thousand tons |
| 2025 | Exhibition of experimental structures at Expo 2025 Osaka | |
| 2029 | Construction of 2-3 low-rise CCC buildings | 2 thousand tons |
| 2040 | 1.725 times increase annually | 345 thousand tons |
| 2050 | 50% of concrete structures are CCC construction. | 110,000 thousand tons |

## Concrete to be "White Carbon"! "White Carbon" following Green Carbon and Blue Carbon reduces global warming.

Concrete can create carbon capture and storage in human ecosystems in addition to continental and marine ecosystems.