March 13, 2024

Kajima Corporation

Trial construction project of the "CUCO-SUICOM Dome" completed, achieving a 70% reduction in CO_2 emissions:

Constructing an environmentally-friendly concrete dome for Expo 2025 Osaka, Kansai

As part of the NEDO[*1] Green Innovation Fund Project "Development of Technology for Producing Concrete and Cement Using CO_2," (hereinafter "the Project"), Kajima Corporation (President: Hiromasa Amano; hereinafter "Kajima") took on the role as a managing company along with Denka Company Limited and Takenaka Corporation for a consortium called CUCO promoting the development of CO_2-absorbing concrete[*2] that achieves lower than net-zero carbon dioxide (CO_2) emissions.

Kajima has recently completed a trial construction project of the "CUCO-SUICOM Dome" at a plot adjacent to the Kajima Technical Research Institute (Chofu, Tokyo). The dome uses Kajima's proprietary "KT Dome" technology and incorporates a type of low-carbon concrete called "ECM Concrete[*3]" along with a type of CO_2-absorbing concrete called "CUCO-SUICOM Shotcrete" for the shell. At the trial construction site, both types of concrete were sprayed and carbonation curing[*4] of the "CUCO-SUICOM Shotcrete" was conducted. This is the world's first environmentally-friendly concrete dome constructed in this way using both materials with KT Dome technology. With this approach, CO_2 emissions have been successfully reduced by 70% compared to conventional shotcrete.

Based on this performance, there are plans to construct another CUCO-SUICOM Dome at a similar scale as in the trial construction project at the site of the 2025 World Exposition (hereinafter Expo 2025 Osaka, Kansai), as part of the activities in the Project.

Going forward, NEDO and CUCO will strive to establish construction technologies for environmentally-friendly concrete structures that use CO_2-absorbing concrete or low-carbon concrete, thereby contributing towards the realization of a carbon-neutral society.

*1 New Energy and Industrial Technology Development Organization
*2 Concrete that reduces, fixes, and absorbs more CO_2 than that emitted during production
*3 Concrete jointly developed by one university and seven companies for a NEDO project involving ECM cement
*4 A method of curing concrete within an environment with highly-concentrated CO_2 for stable absorption and fixation

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The exterior of the CUCO-SUICOM Dome

[Background of development]

The “KT Dome” developed by Kajima is created by pumping air into a dome-shaped polyvinyl chloride (PVC) membrane made at a Japanese factory, whereupon reinforcement bars are installed inside and concrete is sprayed to create a dome-shaped shell. As construction is conducted within the dome, the work is impacted less by weather conditions, enabling swift construction on a stable schedule. The concrete sprayed to create the shell structure includes cement that involves a large volume of CO_2 emissions in production, and so there was a need to establish a type of environmentally-friendly concrete as well as a construction method for this type of concrete.

To address this issue, Kajima established a new spraying method for the KT Dome shell that combines the low-carbon “ECM Concrete” and the CO_2-absorbing concrete called “CUCO-SUICOM Shotcrete,” with plans to apply this method for construction at Expo 2025 Osaka, Kansai site.

One aspect of the concept for Expo 2025 Osaka, Kansai is “A place where the world’s knowledge such as cutting-edge technology will be brought together, used to create new ideas, and shared, all to help resolve global issues facing mankind.” We believe the CUCO-SUICOM Dome will contribute toward the development of new construction technologies aimed at addressing the reduction of CO_2 emissions—an issue faced by the entire human race.

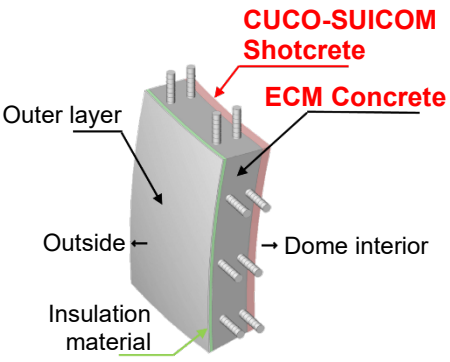
[Overview of technologies and achievements]

The shell structure of the CUCO-SUICOM Dome was created by installing insulation materials and other materials within the inflated membrane, installing reinforcement bars, spraying ECM Concrete, and then spraying CUCO-SUICOM Shotcrete. As CUCO-SUICOM Shotcrete solidifies while absorbing and fixing CO_2, the dome was sealed after spraying to let the concrete cure for a set

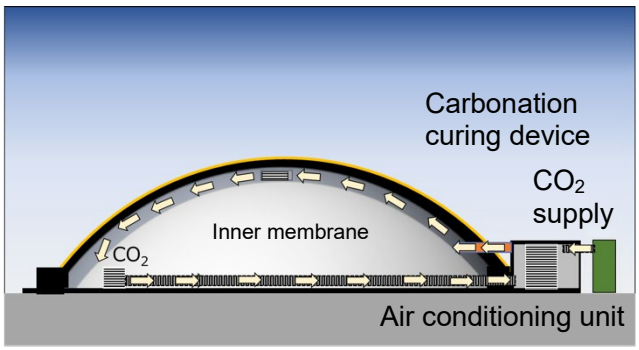
amount of time in a CO_2-filled environment. Kajima's insight and expertise were utilized to implement creative ideas for the materials and mixtures that enabled both types of concrete to be sprayed. Furthermore, a new method was incorporated for the carbonation curing of CUCO-SUICOM Shotcrete, whereby a slightly smaller dome (inner membrane) was inflated within the main dome, and CO_2 was filled into the space between the main dome and inner dome. This resulted in a reduction in the amount of CO_2 used, while also reducing the energy required for the filling process. Regarding the thickness of the concrete layers, the duration of carbonation curing in coordination with the overall construction period was calculated and a thickness of 33 mm was decided on for CUCO-SUICOM Shotcrete and 167 mm for ECM Concrete (267 mm for reinforced openings).

By using ECM Concrete and CUCO-SUICOM Shotcrete for the shell structure in this trial construction project, a 70% reduction in CO_2 emissions from materials compared to conventional shotcrete was achieved.

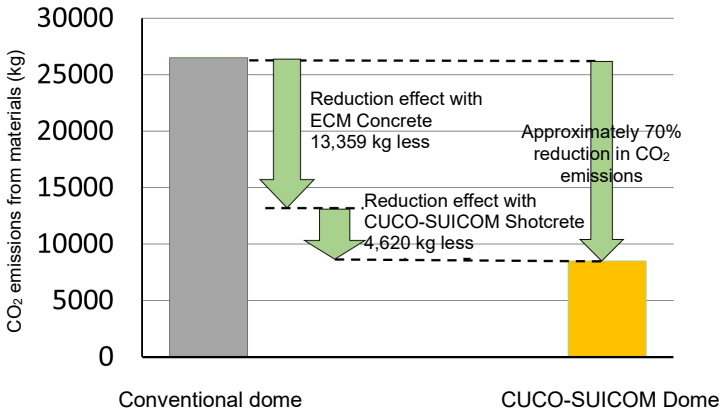
Notably, this marks the world's first construction of a dome utilizing both types of shotcrete along with the application of CUCO-SUICOM Shotcrete for the shell structure.



Cross-section of the CUCO-SUICOM Dome



How carbonation curing works



The effect in reducing CO_2 emissions from concrete

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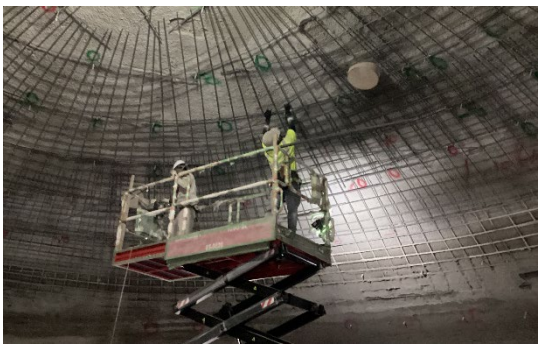
[Construction procedure]

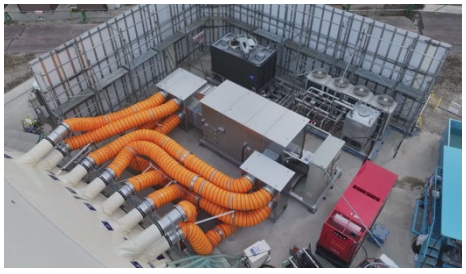
(1) An air blower was used to inflate a dome-shaped polyvinyl chloride (PVC) membrane made at a Japanese factory.



(2) Insulation and other materials were installed within the inflated dome, after which reinforcement bars were installed. Next, ECM Concrete and then CUCO-SUICOM Shotcrete were sprayed to create a reinforced concrete dome structure.




(3) Equipment and internal ducts were installed for carbonation curing. After this, an inner membrane was inflated within the dome before filling the space between the main dome and the inner membrane with CO_2 to conduct carbonation curing of the CUCO-SUICOM Shotcrete.



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[Future developments]

Another CUCO-SUICOM Dome is scheduled to be constructed at the Expo 2025 Osaka, Kansai site using this environmentally-friendly concrete dome construction method.

NEDO and CUCO intend to continue pursuing further research and development to contribute towards realizing a carbon-neutral society by 2050.

Exterior of the CUCO-SUICOM Dome (perspective drawing)

(Reference)

- Development of ECM Cement capable of reducing energy consumption and CO_2 emissions by 60% or more (Press release from August 5, 2014 in Japanese)
  https://www.kajima.co.jp/news/press/201408/5c1-j.htm

- The “KT Dome” construction method has been applied to actual construction, realizing a large and open space without beams and columns by using a dome-shaped structure (Press release from December 23, 2021 in Japanese)
  https://www.kajima.co.jp/news/press/202112/23a1-j.htm

- “Development of Technology for Producing Concrete and Cement Using CO_2,” proposed as part of a consortium, has been selected for a NEDO Green Innovation Fund Project (Press release from January 28, 2022 in Japanese)
  https://www.kajima.co.jp/news/press/202201/28c1-j.htm