

RECLAMATION

Managing Water in the West

Evaluating TRANSCEND ERC as a Viable Alternative for Carbon Neutral Cementation and Digital Fabrication

**Research and Development Office
Science and Technology Program
(Final Report) ST-2016-1784-01**



**U.S. Department of the Interior
Bureau of Reclamation
Research and Development Office**

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Executive Summary

Cement production is responsible for 7% to 9% of global CO₂ emissions. Industry is looking for ways to reduce their impact on the environment. Many companies are looking at various methods of carbon reduction or sequestration but it is on a very small scale compared to the amount of cement produced each a year. The cement industry is changing, looking for more environmentally friendly methods for producing quality cements.

The Bureau of Reclamation has been asked to participate in a cooperative being led by Dr. Gaurav Sant at UCLA and Dr. Edward Garboczi of NIST. The cooperative is titled TRANSCEND ERC and is a new cooperative of researchers and industry who are developing a carbon neutral cement production technology using membranes to capture the CO₂ flue gases and modify it for inclusion in the cement. While aimed at the cement production industry, the technology could also be used on power generation plants using coal or natural gas to capture CO₂ and also modify it for inclusion in cement for concrete. This scoping effort was to determine if our participation in the TRANSCEND cooperative would be beneficial to those served by Reclamation.

Reclamation attended TRANSCEND consortium meetings on November 15, 2017 and April 26, 2018 in California. Another meeting was held on November 30, 2018 in Boston but Reclamation was not able to attend. Presentation slides were provided but have not been made part of this report at the presenter's request. Presentation proceedings can be obtained by contacting the preparer of this report.

Reclamation would benefit greatly by continuing to be involved in the TRANSCEND multi-year consortium. Reclamation has a responsibility to construct structures as environmentally friendly as possible. This includes exploring production methods for materials used to construct our facilities. Cement used in concrete has been labeled as one of the most environmentally unfriendly products to produce. Reclamation has a large inventory of concrete structures and continues to build and modify them using concrete due to concrete's flexibility of use in the design of water storage and conveyance, durably as a building material and long lifespan. If Reclamation has an opportunity to play a role along with industry to make concrete more environmentally friendly, we share a responsibility to investigate that alternative.

Our structures have a 100 year service life partly because of the way we specify our materials. We must be assured that the new technologies are going to be able to support our design criteria. If we have an opportunity to have input upfront to assure that our needs are addressed while assisting in the development of an environmentally friendlier production method, we should participate.

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Background

Four billion tons of cement are produced globally each year and 0.8 tons of CO₂ are produced per ton of cement. Can the CO₂ generated during cement production be sequestered into the cement clinker during the production of cement? Will the cement perform as well as traditional cements? TRANSCEND is a multidisciplinary engineering research center whose mission is to transform construction by carbon-neutral cementation. TRANSCEND has asked Reclamation to participate in the development of this technology by providing input from an owner/specifier perspective.

The consortium title TRANSCEND is an acronym for *Transforming Construction by CO₂ Neutral Cementation and Digital Fabrication*. The vision statement for TRANSCEND is “TRANSCEND will transform the materials, design methods, and fabrication processes used by the concrete construction industry by developing: (i) cementation agents that sequester CO₂, and, (ii) digital fabrication methods that are required to create structural components with unparalleled strength-to-weight ratios and superior structural capacity.”

The TRANSCEND ERC technology is attempting to retrofit existing plants to capture the CO₂ emitted during production and introducing it back into the production process, capturing the CO₂ within the cement used for concrete. This methodology would be incorporated into every ton of cement produced and can be done on a scale equal to today's cement production. In addition, the new cement can be easily incorporated into concrete making batch plants.

This is a new technology that is under the early stages of development. There are several other methods of limiting CO₂ or capturing the CO₂ which have been documented. Many of these other proposed methods would be difficult to incorporate into the large existing infrastructure for the manufacture of cement and concrete, thus their adaption would be problematic. Reclamation has also conducted research on alternative cementitious materials but has yet to be involved with a cement that has sequestered CO₂.

Researchers at UCLA have conducted pilot scale testing under the name CO₂NCRETE™. This product is batched using traditional concrete production methods and then the material is placed into forms. The concrete is then cured using captured flue gas and the concrete carbonates, and captures >65% CO₂.

Reclamation is a large consumer of cement and needs to be at the forefront in helping to develop some of these technologies so that our requirements for cement are taken into consideration. Developing and implementing cleaner construction materials is mandated by government currently. This technology could have a substantial impact on how cement is manufactured. This change in technology could affect concrete properties thus effecting Reclamation design and structure life cycle. We were asked to participate because we are an owner that constructs large concrete facilities over a large geographical area, which the partnership values. The development of this technology could significantly reduce the environmental impact of manufacturing cement for use in Reclamation structures.

Evaluating TRANSCEND ERC as a Viable Alternative

The development of the TRANSCEND ERC technology could reduce the CO₂ generated during the production of cement significantly and cement could be produced in large enough quantities to supply the needs of Reclamation and other users without building new cement plants or infrastructure.

The application of the research would help to reduce carbon emissions into the environment. With the number of construction projects that Reclamation undertakes in a given year, our use of cement produced using this technology would greatly reduce our impact on the environment, but we need to have input into the process so that we do not lose the quality of cement we need for long service of our structures.

During the consortium meetings that were attended, it was evident that Reclamation's participation in this technology could take many roles; from a technical supporter role to more of a hands-on research and testing contribution. Currently for the 2019 fiscal year, Reclamation's Science and Technology Office has not funded further participation for the Concrete, Geotechnical and Structural Laboratory, however, if future funding becomes available the authors of this brief scoping study paper believe there is a contribution to be made.