MATERIAL CYCLES and WASTE MANAGEMENT RESEARCH

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Abstructs

【Special Issues: Trends in Cement and Concrete that Support Carbon Neutrality】

1. Global Cement and Concrete Industry Decarbonization Trends

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Abstract

In an effort to achieve carbon neutrality by the year 2050, expectations are growing surrounding the sequestration of CO_2 from the atmosphere and exhaust gases through the carbonation of cement and concrete. In light of this, various R&D and practical applications are being promoted worldwide. This review introduces state-of-the-art technological developments related to CCUS using cement and concrete, including: Transition of CO_2 emissions in the construction and cement/concrete industries; Outline of measures for carbon neutralization; Outline of various technologies for low-carbonization; Decarbonization at each stage of the concrete lifecycle; Development of additions and aggregates made of artificial calcium carbonate; Development of cement/concrete binders that react and harden with CO_2; and Development of calcium carbonate concrete. Requirements are also indicated for concrete to develop into a carbon-neutral construction material.

Keywords: carbon neutral, concrete, CCUS (Carbon Capture, Utilization and Storage), calcium carbonate

2. Research and Development of Innovative Carbon-negative Concrete

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Abstract

A consortium comprised of Kajima Corporation, Denka Company Limited, and Takenaka Corporation, along with 44 companies and 11 research institutions, has proposed the development of “Innovative carbon-negative (CN) Concrete: Materials, Construction Techniques, and Quality Control Technology.” This proposal has been selected for funding by the Green Innovation Fund project, managed by the New Energy and Industrial Technology Development Organization (NEDO) in Japan. It involves companies from all sectors of the construction industry, pooling their research and execution capabilities, to transform the Japanese concrete industry. The consortium aims to bring together various technologies that contribute to the reduction and fixation of CO_2 and implement expertise acquired over the years to promote the development of environmentally friendly concrete. The goal is to integrate the various techniques to create a new generation of concrete that is carbon-negative by the year 2030. This ambitious project is driven by the shared determination to combat climate change and promote sustainable construction practices.

Keywords: Green Innovation Fund Project, CO_2, environmentally friendly concrete, carbon-negative concrete, CUCO

3. Resource Recycling of Concrete Waste and Development of Carbon Pool Concrete

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Abstract

Carbon Pool Concrete, which is being developed under the NEDO Green Innovation Fund Project, is a new carbon-neutral concrete that uses concrete waste as a recycled resource. Concrete mass totals 36.9 million tons per year, with 2.25 million m3 of residual and returned concrete being generated annually. Each material is expected to come close to achieving the targeted fixation amount of CO_2 gas together with moisture. In the future, we plan to study more efficient fixation methods and methods for fixing the materials to concrete, but it will be necessary to first fully evaluate not only the fixation amount of the materials used, but also: the treatment method, the state of CO_2 used, and the selection of a suitable site for the treatment plant from the viewpoint of LCA.

Keywords: carbon neutral concrete, CO_2 fixation, waste, resource recycling, LCA

4. Quantitative Determination Methods for CO_2 Sequestrated in Cementitous and Concrete Materials

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Abstract

Various CO_2 fixation technologies are under development in the cement and concrete fields. In line with this, many organizations have been studying mass evaluation technologies for sequestrated CO_2 that are currently in the process of being JIS standardized. This paper outlines differential thermal-thermogravimetric analysis, wet analysis, total organic carbon analyzer, and coulometer methods. It presents examples of their application and discusses the issues surrounding these. Although all of the CO_2 fixation evaluation techniques are currently capable of quantifying CO_2 fixation with a certain degree of reliability, further research and development will be required. This will include revision of testing methods, as it is expected that more types of CO_2 fixation materials and concrete can be developed in the future.

Keywords: CO_2, concrete, sequestration, estimation, analysis

5. Recycling of Returned Concrete using Granulated Technology

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Abstract

One of the methods for recycling returned concrete, of which 1 to 2 million m3 is generated annually, is to use granulated recycled aggregate in concrete. RRCS (Ready-mixed & Returned Concrete Solution Association) conducted tests at 42 ready-mixed concrete plants nationwide with the aim of promoting the use of granulated recycled aggregate. The test results showed that the physical properties of granulated recycled aggregate almost satisfied the standard values equivalent to recycled aggregate Class L. In addition, it was found that the compressive strength of concrete produced by replacing ordinary aggregate with granulated recycled aggregate decreased little when the replacement ratio of granulated recycled fine aggregate was less than 30% and that of granulated recycled coarse aggregate was less than 100%. Furthermore, the RRCS has proposed the concept of a returned concrete station for the widespread use of granulated recycled aggregate, since not only the technical aspects but also the facilities for granulation and production of granulated recycled aggregate concrete and its utilization are issues to be addressed.

Keywords: concrete, recycle, returned concrete, recycled aggregate

6. Fundamental Study for High-level Utilization of Concrete Blocks Made from Fresh Ready-mixed Concrete Waste

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Abstract

“Fresh ready-mixed concrete waste” at construction sites is defined as fresh concrete that is leftover after casting because the amount of ready-mixed concrete ordered by the construction site was larger than the required amount. When the ordered quantity of ready-mixed concrete falls short of the required quantity, it has a significant impact on the construction schedule. This is a problem which is difficult to completely eliminate whether the quantity is small or large. It is therefore an issue to be solved from the viewpoint of sustainability in concrete distribution, especially from the viewpoint of waste recycling. Possible reuse methods are being studied from various angles by various companies, and one of the most common methods is to use fresh ready-mixed concrete waste to make concrete blocks. In this manuscript, based on the fundamental research presented so far, this paper describes the factors necessary for the advanced utilization of fresh ready-mixed concrete waste.

Keywords: leftover ready-mixed concrete waste・returned ready-mixed concrete waste, concrete block, recycling, standardization study

7. Research and Development of Mineral Carbonation Techniques in the Republic of South Africa

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Abstract

This paper introduces the content of the CRER project being implemented in the Republic of South Africa under the Science and Technology Research Partnership for Sustainable Development (SATREPS). The CRER project is scheduled to be implemented over a five-year period starting in fiscal year 2021 and is primarily targeting the cement industry in the Republic of South Africa. It aims to develop mineral carbonation technologies in order to reduce CO_2 emissions and environmental remediation technologies using byproducts. One of the project's other main objectives is to develop young talents and implement the technologies in the partner country. Hence, this paper presents an overview of the activities in the field and the academic results obtained from the project.

Keywords: CO_2, mineral carbonation, Republic of South Africa, cement industry, environmental remediation