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Commentaries

Method of Rapid Test for Identification of Alkali-silica Reactivity of Recycled Aggregate Class H

Yasuhiro KURODA[*1], Takatsugu MANO[*2], Yasunori SUZUKI[*3] and Takafumi NOGUCHI[*4]

Keywords: recycled aggregate, alkali-silica reactivity, rapid test, pessimum content

In order to promote the usage of recycle aggregate, creating the proper method of an evaluation test of alkali-silica reactivity is required. Therefore, JIS draft revision committee of recycled aggregate has proposed "the method of rapid test for identification of alkali-silica reactivity of recycled aggregate class H" to become a part of JIS A 5021"Recycled aggregate for concrete - class H" as one of the JIS draft revision plans of 2011. It is important to be aware of the effect of pessimum content since alkali-silica reactivity of recycled aggregate depends on how adherent cement-paste works for aggregates and the status of the progressing condition of alkali-silica reaction.

Based on JIS A 1804 "Method of test for production control of concrete – Method of rapid test for identification of alkali-silica reactivity of aggregate", the experiments were conducted with a different ratio of aggregate sample (Table1) and standard sand.

The results are illustrated in Fig1 and Fig2, which shows that most mortar samples which contain more than 50% of aggregate sample resulted as pessimum (mortar expansion rate was peaked). This led to the upper limit of the expansion rate for mortar, with 50% of the aggregate sample, decreased to 0.07% rather than the standard value 0.10%. Extra examination, 25%, 75%, 100% of aggregate sample mixing rate for mortar samples were added to mortar samples with results of the expansion rate between 0.07% and 0.10%, and if all results of mortar expansion rate achieved 0.10% or less it was distinguished as "harmless"

Table1 Aggregate Sample

MARK	Original Aggregate		Original Concrete			Type of Recycled Aggregate
	Category	Alkali Silica Activety	Cement	NaOH	Crack	
A	Clayslate/Shale Sedimentary rock	Chemical method Sc：90mmol/L, Rc：50mmol/L Rapid test Expansion rate：0.236%	OPC	—	Unfound	Recycled Coarse Aggregate H/M
B				8kg/m^3	Found	Recycled Coarse Aggregate H
C				8kg/m^3	Found	Recycled Coarse Aggregate M
D			BB	8kg/m^3	Unfound	Recycled Coarse Aggregate H/M
E			OPC	8kg/m^3 —	Found Unfound	Recycled Fine Aggregate H
F	Andesite Igneous rock	Chemical method Sc：688mmol/L, Rc：78mmol/L Mortar-bar method Expansion rate：0.31%	Original Aggregate			
G			OPC	8kg/m^3	Found	Concrete Specimen

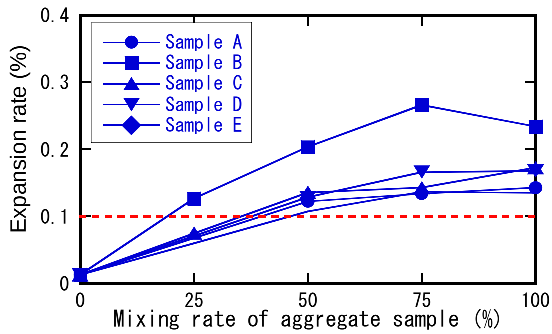

Fig1 Rapid Test Results(Sedimentary rock)

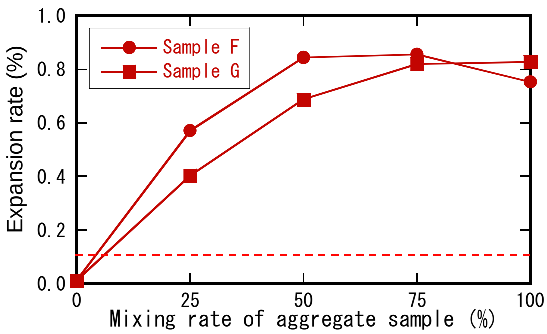

Fig2 Rapid Test Results(Igneous rock)

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Technical reports

CO_2 Uptake over Service Period of Concrete Structures and Recycling Process of Concrete Rubbles

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Keywords: CO_2 uptake, $LCCO_2$, carbonation, neutralization, recycling concrete, concrete rubbles, recycled concrete aggregate for road subbase

Introduction Carbonation is one of the most important phenomena on durability of reinforced concrete structures. The concern with carbonation in perspective of global warming has been growing. The amount of CO_2 absorbed in concrete, however, has not been quantified. In this paper, we examine CO_2 uptake in concrete over its service period and recycling process.

Mechanism of CO_2 uptake The major raw material of cement is limestone. Limestone decarbonates through calcination. After concrete mixing, hydration of CaO (C) in cement results $Ca(OH)_2$ (CH) and $(CaO)_3(SiO_2)_2(H_2O)_3$ (C-S-H), which absorb CO_2 in the atmosphere. CO_2 behaviors through life cycle of concrete are written as follows:

- Calcination (cement manufacturing):
  CC → CaO + CO_2 (CC denotes $CaCO_3$),
- Hydration (concrete mixing):
  C_nS + H → CH, C-S-H (n is 2 or 3. S and H denote SiO_2 and H_2O, respectively.),
- Carbonation (service period and recycling):
  CH + CO_2 → CC + H,
  C-S-H + $3CO_2$ → 3CC + S + 3H.

Method We collected 46 specimens of recycled concrete aggregate around Japan. The service period of the specimens was about 30 years on average. Each specimen was divided into two parts. For one part, the amount of CO_2 was measured immediately (indicating uptake during service period of concrete structures), and for the other, after 28-day exposure at ordinary temperature, pressure and CO_2 concentration. The exposure period is similar to that in a recycling site. During the exposure, the specimens were watered two times a week. CO_2 uptake was quantified by TG-DTA analysis. The measurement methods are shown in Table.1.

Results The amount of CO_2 uptake is shown in Figure.1. Initially, recycled concrete aggregate absorbed 15.2kg-CO_2/t. This amount corresponds to about 25% of decarbonated CO_2 through calcination. Moreover, recycled concrete aggregate absorbed 8.5kg-CO_2/t during 28-day exposure. This amount is comparable with CO_2 emissions due to energy consumption through the recycling process. The smaller grain size is, the more CO_2 concrete absorbs. Cement content seems to have little influence on CO_2 uptake.

Table.1 Method of Measurement

Items	Method	Information obtained
CC	TG-DTA (CC:600-1000,CH:450-500°C)	CO_2 Uptake
CH		
Grain Size	JIS A 1102, JAPAN Road Assoc. method	Influence on CO_2 Uptake
Insoluble Residue	JAPAN Cement Assoc. method F-18	Cement Content, Influence on CO_2 Uptake
C		

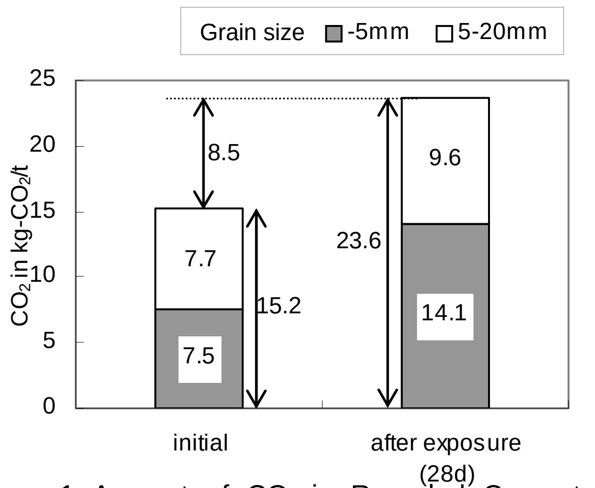

Figure.1 Amount of CO_2 in Recycled Concrete Aggregate

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Technical reports

A Survey of Performance for Systems of Cathodic Protection of the Concrete Railway Bridge

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Keywords: salt damage, rebar corrosion, cathodic protection, maintenance, deterioration and damage

Cathodic protection (CP) is attracting higher attention as a countermeasure to the drastic salt-damage of a concrete structure. Limited number of literature is available on the long-term performance and analysis of the protection, despite the variety of CP methods. The present paper reports on a long-term monitoring and analyses of CP applied to a railway bridge of prestressed concrete located on the coastal zone of Sea of Japan where the most severe salt-damage is reported. Analysis and discussion are given to the electrochemical data collected on site for ten years.

The potential of rebar was measured following disconnection from anode to determine the amount of depolarization, which exceeded 100mV and satisfied the protection criterion for all types of CP.

Fig.1 and Fig2 are pictures for Zn sheet and thermal-sprayed Ti anode methods, respectively. Correspondingly, plots of off-potentials vs. current density are illustrated in Fig.3 and Fig.4. Cathodic protection in concrete is classified into two processes, anode and cathode controls.

Fig.1 Picture of Zn sheet method

Fig.2 Picture of thermal sprayed-Ti anode method

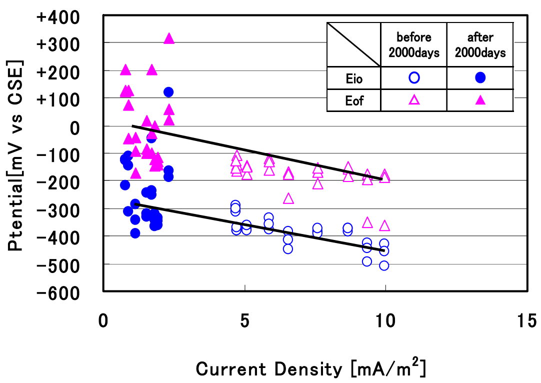

Fig.3 Plots of off-potentials vs. current density for Zn sheet method showing cathode-control nature.

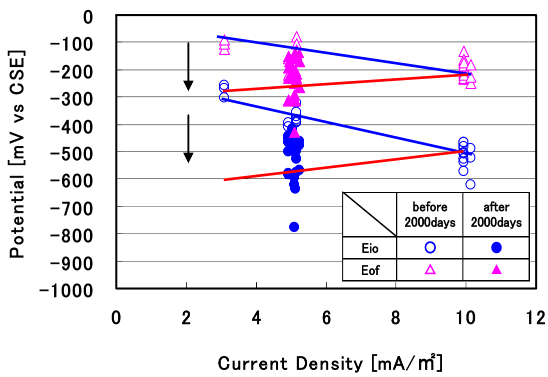

Fig.4 Plots of off-potentials vs. current density for thermal sprayed-Ti anode method showing anode- control nature.

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Construction records

High-rise Building Operations Using Ultra-high Strength Precast Concrete with a Design Strength of 200 MPa

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Keywords: 200 MPa design strength, ultra-high strength precast concrete, superhigh-rise condominium, steam curing

Precast concrete with design strength greater than 150 MPa is now being put to practical use as the importance of skyscrapers increases. The realization of higher-strength concrete enables the creation of larger spaces through reduced member sizes and increased spans lengths. On the other hand, with increased concern about the global environment, the demand for longer-life buildings is also increasing. Against this background, expectations regarding higher-strength precast concrete are growing because of its excellent quality and durability.

Therefore, we developed ultra-high strength precast concrete with a design strength of 200 MPa. This paper describes the production processes and quality control results for precast concrete columns with a design strength of 200 MPa. These columns were used for the first time in superhigh-rise reinforced concrete condominiums (Photo 1).

To produce 200 MPa precast concrete with excellent workability and strength development, a mineral admixture that we specifically developed for this purpose was used. An expanding material and a superplasticizer containing a shrinkage-reducing component were used to inhibit cracking in concrete due to autogenous shrinkage. The unit water content was measured by the submerged mass method, as well as a series of fresh concrete tests in regard to the slump flow and air content. Precast concrete columns were produced and then steam-cured at 90°C at our company's precast concrete factory.

Ultra-high strength precast concrete with a design strength of 200 MPa having stable qualities was produced by strictly controlling the unit water content and other control items. The concrete was found to have sufficient fluidity for placing (Photo 2). The compressive strength exceeded 200 MPa and fulfilled the requirements. Photo 3 shows the state of precast column erection.

Photo 1 The superhigh-rise condominium in which precast concrete with 200 MPa was used

Photo 2 Concrete placing in horizontal position

Photo 3 Erection of precast column

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