CO_2 Uptake through Recycling of Concrete Rubbles

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1. Introduction

The recycling level of concrete rubbles following demolition of civil engineering structures has been kept at about 98 percent in Japan, since the "Construction Material Recycling Law" came into effect. Almost all the concrete rubbles are recycled as aggregates. Recently, some researchers report that CO_2 uptake to concrete structures during their life cycle is not negligible. The process of CO_2 uptake is known as carbonation (or neutralization), the reaction of Ca ions in cement (pH is high) with carbonate ions in the atmosphere. The uptake rate probably becomes higher in a recycling process because the surface area of the cement is increased by the demolition and crushing processes.

The amount of the CO_2 uptake should be subtracted from the amount of CO_2 emissions due to the energy consumption etc. in the calculation of the net CO_2 emission during the recycling process. In the present paper, we introduce our nation-wide investigation to determine the amount of the CO_2 uptake through recycling of concrete rubbles.

2. Mechanism of CO_2 uptake

Limestone is a main raw material of cement, which is decomposed into CaO and CO_2 in the calcination process. During the hydrate process, CaO in cement paste transmutes into $Ca(OH)_2$ which absorbs the atmospheric CO_2. The CO_2 behavior through life cycle of concrete structure can be written as follows. In addition to $Ca(OH)_2$, calcium silicate hydrate (C-S-H) also absorbs CO_2.

(i) Cement manufacturing: $CaCO_3 \rightarrow CaO+CO_2$
(ii) Hydration (concrete mixing): $CaO+H_2O \rightarrow Ca(OH)_2$
(iii) Use (service)-: $Ca(OH)_2+CO_2 \rightarrow CaCO_3+H_2O$

3. Overview of nation-wide investigation

We collected 46 specimens of concrete rubbles around the nation. Each specimen was divided into two parts. The amount of CO_2 was measured immediately for one part (denoting uptake during service period of concrete structures), and after 28-day exposure to the environment for the other. Figure 1 shows the result. The amount of CO_2 in the immediately analyzed specimens was 14kg- CO_2/t on average. That increased to 23 kg- CO_2/t after 28-day exposure. The amount of CO_2 uptake through recycling was about 9kg- CO_2/t on average (minimum: 3, maximum 17), calculated as the increment between 28-day exposures. The smaller the grain size was, the more CO_2 the specimen absorbed. This amount is comparable with the amount emitted to produce the recycled concrete aggregates.

4. Future work

We will determine the amount of CO_2 uptake which should be considered in the calculation of the net CO_2 emission due to manufacturing of recycled concrete aggregates. We will identify the influential factors on the CO_2 uptake to propose easy and effective techniques for increasing the amount of CO_2 uptake.

References:

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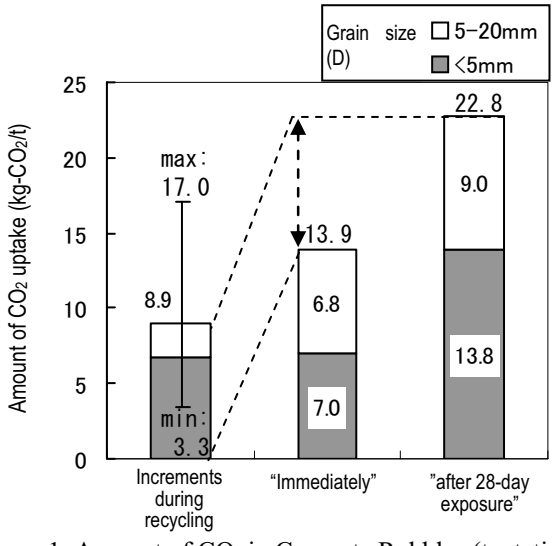

Figure 1. Amount of CO_2 in Concrete Rubbles (tentative)

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