Possibility of CO_2 capturing by geopolymer mortar using Indonesian volcanic mud LUSI

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1. Introduction

Utilization of geopolymer concrete made of biproduct is thought to be one of the solution of CO_2 emission reduction in the construction project. Furthermore, there are research on the CO_2 capturing in geopolymer solids focusing on microstructure[1]. This study investigates the possibility of CO_2 capturing by geopolymer mortar using Indonesian volcanic mud "Lumpur Sidarjo (called LUSI)" to find an advantage of utilization of natural mud which generally requires special handling due to its high water absorption rate[2].

2. Methodology of Experiment

2.1 Materials

Fly ash (FA) classified JIS II was used for the source of binder. Sodium hydroxide solution 12 mol/L and sodium silicate solution were used for general method, and Sodium metasilicate 9-hydrate (SM) was used for dry-mix method[2]. Naturally dried raw LUSI and silica sand were used as fine aggregate. The chemical composition of LUSI was shown in Table 1, together with fly ash. It has been known that the raw LUSI cannot show geo-polymerization alone, even though the chemical composition are similar to fly ash.

Table 1 chemical composition of FA and LUSI

Constituent %	Fly ash	LUSI
SiO_2	57.24	44.14
Al_2O_3	31.07	27.11
CaO	1.86	2.78
Fe_2O_3	3.27	5.73
MgO	2.04	7.80
Na_2O	0.76	5.64
K_2O	1.32	1.40

2.2 Mix and curing

The mix type A and B were determined with 3% volume of air as shown Table 2. The mix type A was the mix design based on the dry-mix method[2] to achieve the equivalent compressive strength of type B. The mix type B was for a general mix design as control specimen. This mix requires 80°C 48 hour oven curing. The average compressive strengths of type A and B at 7days were 37.4 MPa and 37.0 MPa, respectively.

Table 2. Mix design (kg/m³)

	SM (kg/m³)	FA (kg/m³)	LUSI (kg/m³)	Silica sand (kg/m³)	NaOH (kg/m³)	Na_2SiO_3 (kg/m³)
A	969	969	485	0	0	0
B	0	583	0	1166	100	250

2.3 Methodology of measurement of CO_2 capturing

The chamber, sensor for temperature, humidity and CO_2 concentration (ppm), and fan are shown in Fig.1. The specimen is a manufactured block shape of 210mm x 100mm x 60mm in the project of LUSI utilization. After the 7days curing, the formworks was removed, then the block specimen was simply put in the chamber. The CO_2 concentration was not controlled at the beginning of experiment to see the performance in the natural air. The surfaces except the bottom were exhibited until the measured value seemed to be constant.

3. Results and discussions

The example of changes of CO_2 concentration, temperature and humidity in 1500 minutes for Type A and Type B mixes are shown in Figure 2. It took around 600 minutes to find equilibrium state of CO_2 concentration. The decreases of CO_2

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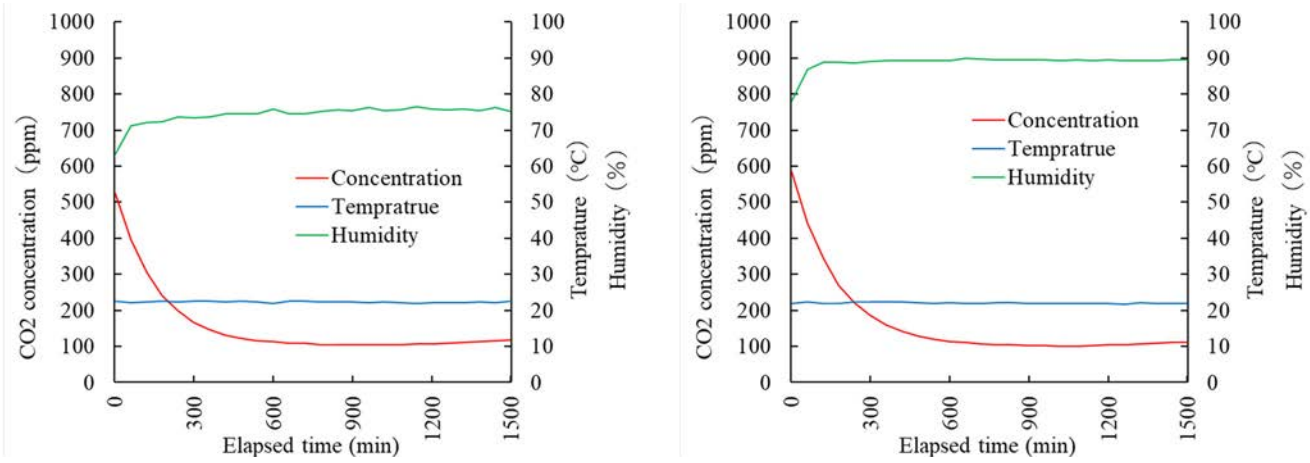
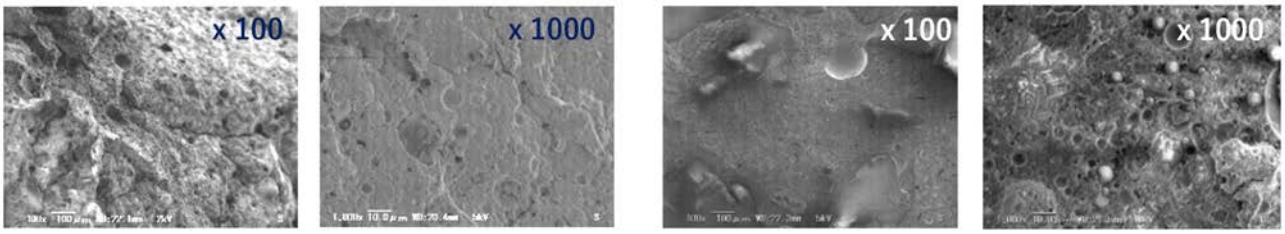
(a) Chamber (b) Sensor and data logger (c) Fan (d) Setting image in chamber

Figure 1 Chamber and measurement tools



(a) Type A (GP mortar with LUSI) (b) Type B (control specimen)



(a) Type A (GP mortar with LUSI) (b) Type B (control specimen)

Figure 3 SEM analysis

concentration were 421 ppm and 484 ppm for type A and B, respectively. Both showed almost same performance of CO_2 capturing, even though the humidity of type B was almost 15% higher than that of type A. Without fan system, the time to reach equilibrium was double, however the trend of decrease was same for both cases.

The magnified images by SEM were shown in Figure 3. For the 100 times magnified images, the undulating surface was observed on type A. For the 1000 times images, somewhat flake based structure was seen on type A, however the pores and unreacted spherical fly ash were observed on type B. It is necessary to clarify the influence of these micro structures on the performance of CO_2 capturing.

4. Conclusions

The possibility of CO_2 capturing by geopolymer mortar using Indonesian volcanic mud LUSI made through the dry-mix method proposed by the authors[2] was confirmed as equivalent to that of fly ash based geopolymer mortar.

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