Cement & Concrete Composites 42 (2013) 1–8

Contents lists available at SciVerse ScienceDirect

Cement & Concrete Composites

journal homepage: www.elsevier.com/locate/cemconcomp

CO_2 curing for improving the properties of concrete blocks containing recycled aggregates

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ARTICLE INFO

Article history:
Received 25 October 2012
Received in revised form 23 April 2013
Accepted 25 April 2013
Available online 4 May 2013

Keywords:
CO_2 curing
Recycled aggregate
Concrete blocks
Properties

ABSTRACT

A CO_2 curing process was adopted to cure concrete blocks made with recycled aggregates. Non-load- and load-bearing blocks were prepared with 0%, 50% and 100% recycled aggregate to replace natural aggregate. The blocks were then placed in a pressurized 100% CO_2 curing chamber for 6, 12 and 24 h. The temperature and relative humidity inside the chamber were monitored, and the moisture loss and CO_2 curing degree were determined by a weighing method. After the curing process, the strength and drying shrinkage of the CO_2 and moist cured blocks were measured. The CO_2 cured blocks attained higher compressive strength and lower drying shrinkage than the corresponding moist cured blocks. However, curing time and amount of recycled aggregate present in the blocks had insignificant effects on the strength gain and CO_2 curing degree.

1. Introduction

Due to the imminent exhaustion of available landfill capacity, the Hong Kong Government has promulgated a series of policies to encourage waste reduction, recycling and reuse in the last decade [1]. As a consequence, reuse and recycling of construction waste, most of which is inert and is known as public fills in Hong Kong, has drawn the attention of researchers and practising engineers. The Hong Kong Polytechnic University [2–4] has put a lot of effort into finding practical methods to recycle construction waste as a secondary aggregate for new concrete and concrete blocks production. Also, similar studies [5–7] have been reported widely in other parts of the world. However, as demonstrated in our previous work, using recycled aggregates to replace natural aggregate has some negative effect on the performance of the new products, especially mechanical properties [3,8], due to the presence of adhered-old cement mortar in the recycled concrete aggregate (RCA). Only with a lower water to cement ratio and a longer curing time, a comparable performance to natural aggregate concrete can be achieved [9,10].

Natural carbonation in air, which is a well-known chemical process of combining cement hydration products with atmospheric carbon dioxide, has been found to be able to improve the mechanical properties [11,12] and reduce the subsequent drying shrinkage [13,14] of concrete products. Previous works [15,16] showed that concrete products have a more rapid strength development rate when compared to the normal hydration process, if the carbonation process is introduced at the early stage of cement hydration. The accelerated carbonation behavior and strength development of calcium silicates, including γ-Ca_2SiO_4, β-Ca2SiO$_4$, $CaSiO_4$ and Portland cement were investigated in the 1970s [17–19]. The compressive strength of a C_3S mortar after 1 h CO_2 curing was comparable to the same mortar after 7 days of moist curing. Furthermore, the post-hydration of the carbonated compacted-cement system increased the compressive strength by 50% in 3 days [20]. Shi and Wu studied the influence of factors on the degree of CO_2 curing of concrete products, including curing time and pressure, and effective water to cement ratio [21,22]. It was noticed that remained water to cement ratio had the most significant effect on the CO_2 curing process [23]. Also, several studies on accelerated carbonation reported the consolidation of concrete waste [24], CO_2 capture using concrete [25] and performance improvement of slag-cement concrete using carbonation [26]. A recent study indicated that CO_2 curing of concrete products was also a diffusion-controlled process [27].

In this paper, the results of a preliminary study on the feasibility of applying CO_2 curing for concrete blocks prepared with recycled aggregate are reported. A 100% CO_2 atmosphere was introduced to a sealed chamber for curing the concrete blocks that were prepared with the incorporation of recycled aggregates. The effect of the CO_2 curing process on the performance of the concrete blocks was assessed in terms of mechanical properties and volume stability.

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http://dx.doi.org/10.1016/j.cemconcomp.2013.04.013

Table 1
Properties of cement used.

Chemical analysis (%)									Physical properties	
CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	Na_2O	K_2O	SO_3	L.O.I	Specific gravity	Fineness (cm^2/g)
63.15	19.61	7.32	3.32	2.14	0.13	0.32	2.03	2.34	3.16	3519

2. Experimental programme

2.1. Materials

The cementitious materials utilized for concrete blocks preparation in this study were ASTM Type I Portland cement. The composition of the cement is given in Table 1.

The aggregate used was crushed fine granite with particle sizes ranging from 0 to 5 mm, and crushed coarse granite from 5 to 10 mm. According to BS EN 1097-6 [28], the determined specified gravity were 2.62, 2.60 for the fine and coarse granite, respectively; while the determined water absorption were 1.23%, 1.24% for the fine and coarse granite, respectively. Recycled aggregate, which was obtained from a construction and demolition waste (C&DW) materials recycling facility in Tuen Mun of Hong Kong (hereinafter referred to as TA) and mainly contained old concrete, was used to replace the crushed fine granite gradually. The measured specified gravity and water absorption of TA were 2.54 and 3.13%, respectively. The particle size distribution of the fine aggregate was determined in accordance with BS EN 12620 [29], and the results are shown in Fig. 1; the requirement on particle size distribution of fine aggregate from BS 882 [30] is also presented in Fig. 1. A commercially supplied CO_2 (Hong Kong Oxygen) cylinder with a CO_2 concentration higher than 99% was used for the CO_2 curing experiment.

2.2. Sample preparation

Two series of mixes, corresponding to non-load bearing (NLB) and load bearing (LB) masonry units, were designed with the following proportions: cement: fine aggregate: coarse aggregate = 1.0:6.5:3.5 and 1.0:2.3:0.7, respectively. In each series, the recycled fine aggregate was used as a replacement of 0% (labeled 'Control'), 50% (labeled 'TA50') and 100% (labeled 'TA100') of crushed fine granite by mass. The used water amount for each mix was different, as each mix was prepared with varying contents of recycled aggregate (TA). Considering the higher water absorption of TA, more water was added into the mix which contained more TA, in order to ensure a more homogeneous mixture and a better compaction. Details of mix proportion for all the concrete blocks are listed in Table 2. The blocks were cast in steel molds with internal dimensions of 70 mm × 70 mm × 70 mm and 25 mm × 25 mm × 285 mm. The 70 mm cubic samples were prepared for compressive strength testing while the prismatic samples were for drying shrinkage measurements. The well-mixed materials were put into the molds in three layers of approximately equal depth. After each of the first two layers was filled, compaction was applied manually using a hammer and a wooden stem. After the third layer was filled, a pressure of approximately 30 MPa was applied and held for 30 s on the specimens. Once the block fabrication was finished, all the specimens were removed from the mold immediately.

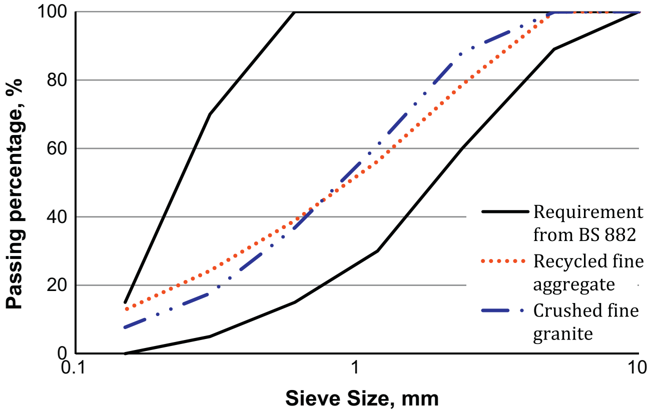


Fig. 1. Particle size distribution of fine aggregates.

2.3. Curing process

Two curing methods, CO_2 curing and moist curing were employed in this study. Fig. 2 illustrates the CO_2 curing set-up. An airtight steel-cylindrical vessel with a volume of about 33 L was used as the CO_2 curing chamber, which was vacuumed to −0.5 bar before the CO_2 gas injection. The CO_2 pressure in the chamber was controlled by a gas regulator and kept at 0.1 bar for 6, 12 and 24 h curing duration. Considering the adverse impact of high humidity on carbonation, anhydrous silica gel was put inside the chamber to remove the evaporated water from the specimens. The CO_2 curing chamber was placed in a room maintained at 23 °C. There were three samples cured in CO_2 curing chamber each time. For moist curing, the specimens were placed over a layer of water in a sealed container (to allow water vapor saturation) for the same duration as the CO_2 curing and the moist curing was used as the reference sample group. The container was also placed in a room maintained at 23 °C.

2.4. Testing methods

2.4.1. Temperature and humidity monitoring

Both the hydration and carbonation of calcium silicates are exothermic reactions, and accompanied by water combination and water vapor generation respectively. Therefore, monitoring of the variation of temperature and humidity inside the chamber is very necessary. Temperature and humidity sensors were placed inside the chamber and a SK-L200TH II α data logger was used to record the temperature and relative humidity variations once every minute during the curing process.

2.4.2. CO_2 uptake, water loss and curing degree

Due to the heat release during the curing process, some free water inside the specimens was evaporated, which subsequently condensed on the inner surface of the chamber or was absorbed by the silica gel in the chamber, resulting in a mass gain of the curing chamber. Also, when CO_2 reacts with the cement clinker minerals and hydration products and is sequestrated, it results in a net mass gain of the specimens. Therefore, before and after the CO_2 curing process, the mass-change of the specimen and the curing chamber with silica gel was measured for the determination of amount of captured CO_2 (M_{CO2}).

Table 2
Mix proportions of concrete blocks.

Notation	LB-control	LB-TA50	LB-TA100	NLB-control	NLB-TA50	NLB-TA100
Cement	1.0	1.0	1.0	1.0	1.0	1.0
Crushed fine granite	2.3	1.15	0	6.5	3.25	0
TA	0	1.15	2.3	0	3.25	6.5
Coarse aggregate	0.7	0.7	0.7	3.5	3.5	3.5

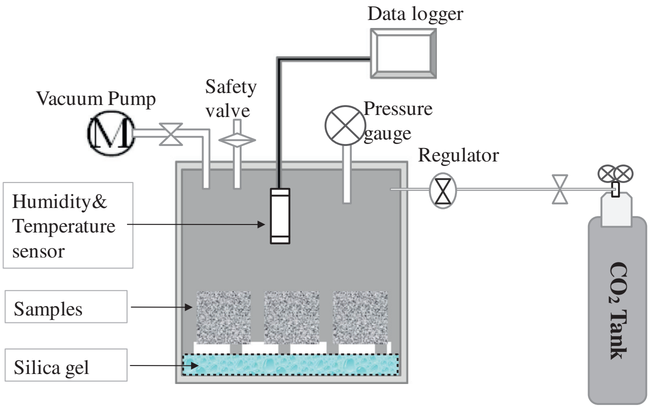


Fig. 2. Illustration of CO_2 curing set-up.

$$M_{CO2} = \Delta M_{specimen} + \Delta M_{water} \tag{2-1}$$

where $\Delta M_{specimen}$ and ΔM_{water} represent the net mass gain of the specimens and the moisture loss.

The CO_2 curing degree (D_{cc}) is defined as the ratio of the actual captured CO_2 amount to the maximum theoretical CO_2 amount captured by cement in the specimens:

$$D_{cc} = M_{CO2}/(M_c CO_{2\%\,max}) \tag{2-2}$$

where M_c represents the cement mass in the specimens, while the maximum theoretical CO_2 ($CO_{2\%max}$) captured by Portland cement can be calculated based on the metal oxide content by the following formula [14,31]:

$$CO_{2\%\,max} = 0.785(CaO - 0.7SO_3) + 1.091MgO + 1.420Na_2O + 0.935K_2O \tag{2-3}$$

According to the chemical compositions of the cement used in this study, which is shown in Table 1, the $CO_{2\%max}$ is 51.3%.

2.4.3. Compressive strength

After the curing process, the compressive strength of the specimens was determined in accordance with BS EN 12390-3:2009 [32], three specimens were used for each test.

2.4.4. Drying shrinkage

After the curing process, all the specimens (25 mm × 25 mm × 285 mm) were placed into a water tank at room temperature for an additional 28 days of water curing; and the initial lengths of the specimens were measured. Then all the specimens were transferred into an environmental chamber at a temperature of 20 °C and a relative humidity of 50% for drying shrinkage measurement. The length measurements were repeated at 1, 3, 7, 14 and 28 days after the initial measurement according to BS 6073 [33]. Three specimens were measured for each test.

3. Results and discussion

3.1. Temperature and humidity variation

Considering the variation of TA content and CO_2 curing time, the typical temperature and relative humidity profiles of three mixes during CO_2 curing process were selected and shown in Fig. 3. It should be noted that nearly for all the cases, the temperature inside the chamber reached the highest about 1 h after CO_2 injection, and then declined gradually. The temperature rise could be attributed to the reactions between CO_2 and cement clinker minerals or hydration products, which are exothermic processes [16,17]:

$$C_3S + (3-x)\bar{C} + yH \rightarrow C_xSH_y + (3-x)C\bar{C} \tag{3-1}$$

$$C_2S + (2-x)\bar{C} + yH \rightarrow C_xSH_y + (2-x)C\bar{C} \tag{3-2}$$

where C_2S and C_3S represent dicalcium silicate and tricalcium silicate, respectively; $\bar{C}$ and $C\bar{C}$ represent carbon dioxide and calcium carbonate, respectively; H and C_xSH_y represent water and calcium silicate hydrates, respectively.

Generally, the peak value was about 3–6 °C higher than the ambient temperature. However, as the curing chamber was not adiabatic, the peak temperature depended not only on the heat liberated from the carbonation reactions, but also the heat transfer capability of the chamber, ambient temperature, the sensor's location, etc. As a consequence, the actual maximum temperature of the sample occurred ahead of time corresponding to the temperature peaks shown in Fig. 3. However, this does not mean that the termination of CO_2 curing occurred when the descending segment of temperature curve appeared. It only indicates that the reactions slowed down.

The humidity level inside the chamber increased significantly with CO_2 injection, and it was maintained at close to 100% for

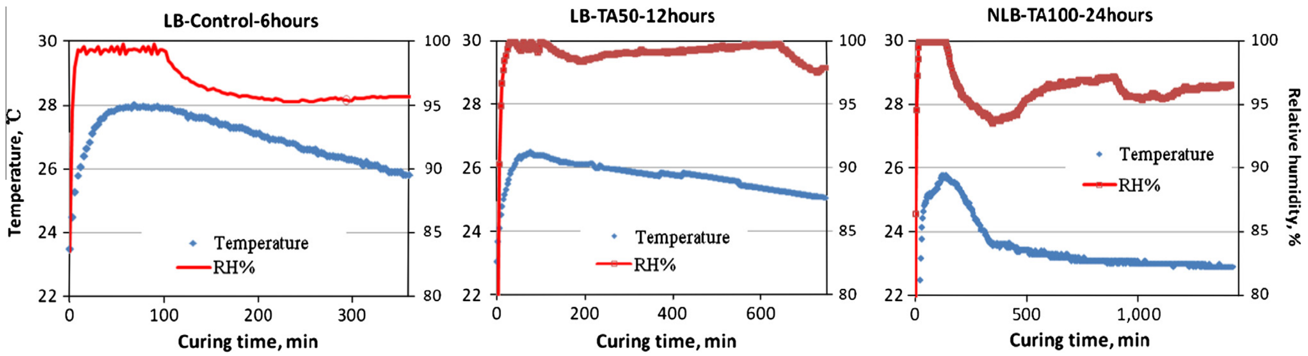


Fig. 3. Typical temperature and relative humidity profiles.

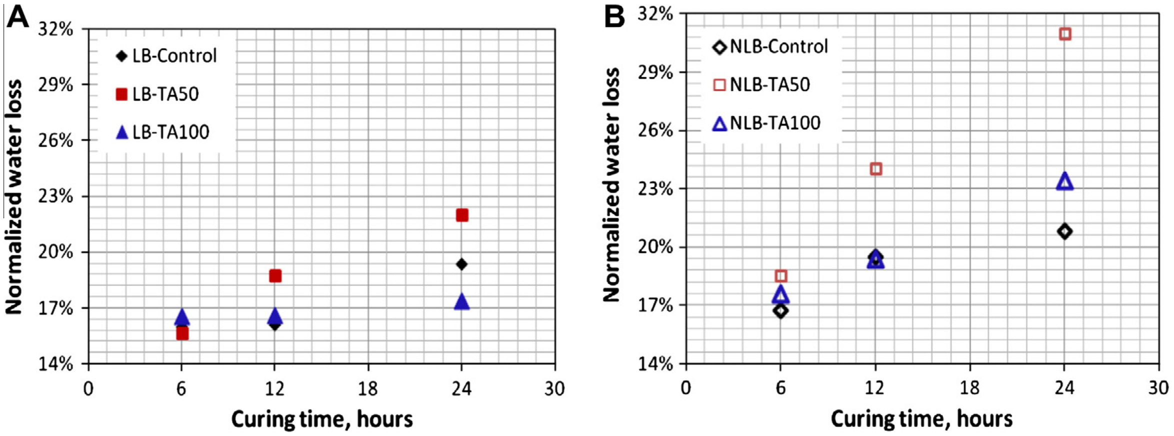


Fig. 4. Variation of normalized water loss during the CO_2 curing. (A) Load-bearing series and (B) non-load-bearing series.

around 1–2 h (Fig. 3). As discussed above, a large amount of heat was released from the carbonation process evaporating water inside the specimens very quickly. Although the silica gel tried to absorb the water vapor, the absorption rate was slower than the evaporation rate resulting in a sharp increase in relative humidity. After then, the relative humidity dropped gradually when the carbonation rate slowed down.

3.2. Water loss and CO_2 curing degree

Fig. 4 illustrates the water loss profiles during the CO_2 curing process. The normalized water loss was defined as a mass ratio of water loss during the curing process to the initial mass of free water present in the specimens. Apparently the water loss of the specimens increased with curing time for both the load-bearing blocks and the non-load-bearing blocks. As the relative humidity inside the chamber was high (⩾95%) throughout the whole curing process leading to a delicate specimen-gas moisture difference, it can be inferred that the heat of carbonation was the major driving force of water evaporation. The normalized water losses of NLB-TA50 and NLB-TA100 after 24 h CO_2 curing were 31.0% and 24.0%, which were much higher than those of LB-TA50 and LB-TA100. For both series, the specimens prepared with TA lost more water than those without TA.

The variation of CO_2 curing degree with curing time is shown in Fig. 5. For the load-bearing series, the blocks with TA (LB-TA50, LB-TA100) obtained a higher curing degree than those without TA, irrespective of the curing time. From 6 to 24 h of curing, the curing degree of LB-TA50 varied from 19.3% to 30.0%, while the NLB-TA50 varied from 17.1% to 32.7%. As curing time increase, a remarkable increase in curing degree also occurred in other blocks with or without TA of both series. Combined with Fig. 4, it might be inferred that when more water was evaporated from the specimens, it resulted in more open pores leading to more effective penetration of CO_2, which could promote the carbonation reactions significantly. This deduction can be confirmed by the approximate linear relationships between CO_2 curing degree and normalized water loss, as shown in Fig. 6.

Furthermore, Fig. 7 illustrates the correlation between the CO_2 curing degree and the replacement ratios of fine aggregate with TA after 6, 12 and 24 h of curing. The use of TA, in theory, is supposed to be able to capture more CO_2 than that of the natural aggregates due to the presence of old cement mortar which can also react with CO_2. However, except for the LB series with 6 and 12 h of CO_2 curing, the specimens prepared with a 50% replacement ratio achieved the highest CO_2 curing degree. To a certain extent the CO_2 curing degree decreased for the specimens of NLB series prepared with 100% TA. This could be explained that, when more TA was used in the concrete blocks, more water was used to ensure an appropriate workability for batch mixing due to the higher water absorption of TA compared to the natural aggregate. The water rich specimens rendered the penetration of CO_2 more difficult.

3.3. Compressive strength

The results in Figs. 8 and 9 reveal the compressive strength development of LB and NLB blocks series with different curing processes and curing times. Compared to moist curing, the CO_2 curing

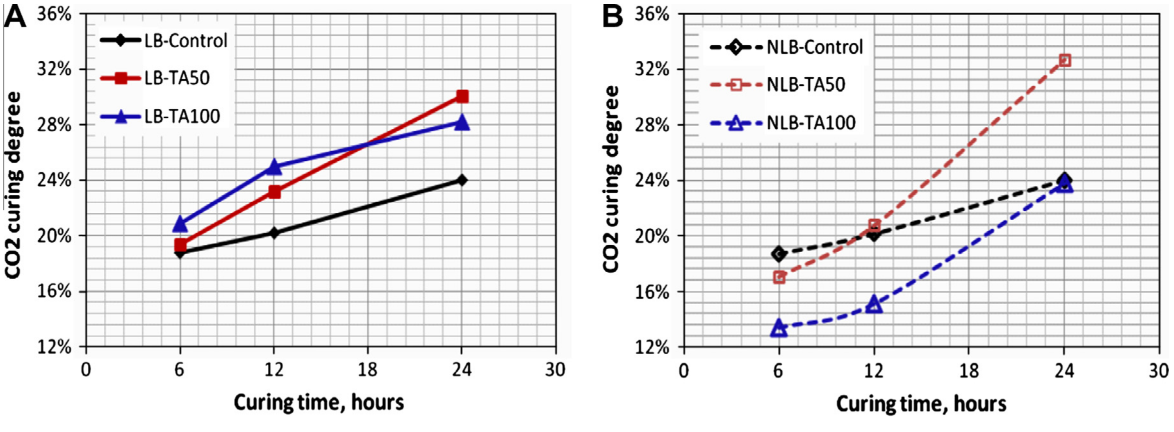


Fig. 5. CO_2 curing degree versus curing time. (A) Load-bearing series and (B) non-load-bearing series.

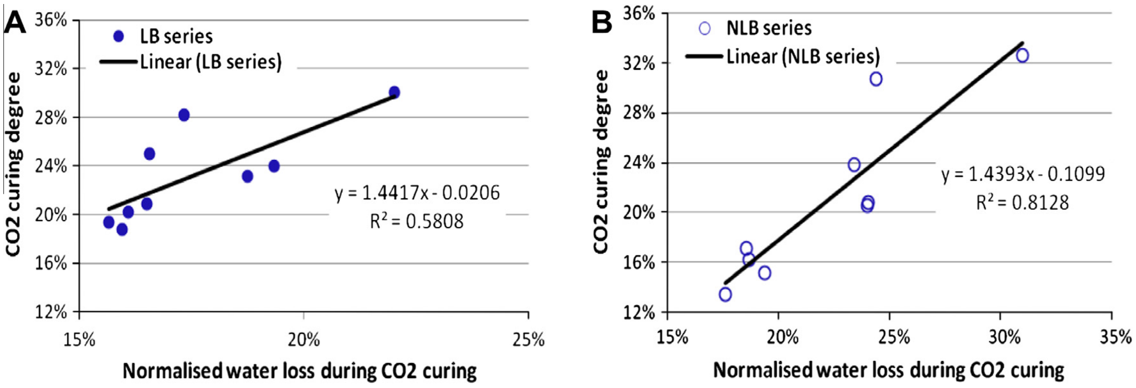


Fig. 6. Relationship between CO_2 curing degree and normalized water loss. (A) Load bearing series and (B) non-load-bearing series.

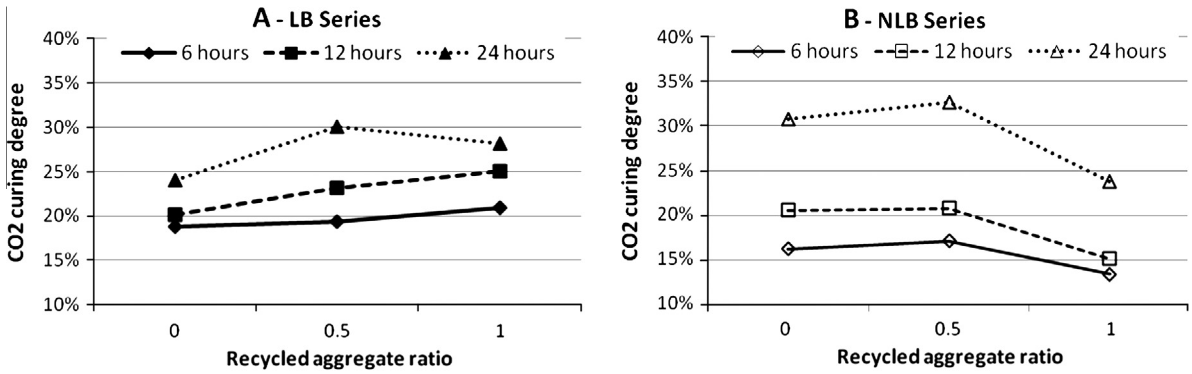


Fig. 7. Relationship between CO_2 curing degree and recycled aggregate ratio. (A) Load bearing series and (B) non-load-bearing series.

process improved the compressive strength of both LB and NLB blocks. After 6 h of curing, a compressive strength of 33.8 MPa was attained by the CO_2 cured LB-TA50 blocks, while only 24.6 MPa was attained for the moist cured counterpart. The same phenomenon could also be observed in NLB-TA50 blocks after 12 h of curing (16.8 MPa for CO_2 cured samples and 11.6 MPa for moist cured samples) and in NLB-TA100 blocks after 24 h of curing (22.7 MPa for CO_2 cured samples and 15.7 MPa for moist cured samples).

For the LB Series, it was apparent that the use of different recycled aggregate amounts had little effect on compressive strength of the CO_2 cured samples as after 24 h of CO_2 curing, the compressive strength of LB-Control, -TA50 and -TA100 were very similar (49.1 MPa, 49.9 MPa and 50.4 MPa, respectively). However, the variation of strength gain is summarized in Table 3, which was determined as a ratio of the compressive strength of the blocks after CO_2 curing to that of the moist cured samples, indicates that both LB and NLB series blocks with TA obtained higher strength gains than the reference group (except 6-h CO_2 cured NLB-TA50 blocks). Moreover, even though 100% TA was used (LB-TA100 and NLB-TA100), the compressive strength of 24 h CO_2 cured blocks were still higher than that of 24 h CO_2/moist cured reference blocks (LB-Control and NLB-Control) which used natural aggregates. The increase in compressive strength could be attributed to the rapid formation of $CaCO_3$ and silica gel, which accelerated the hardening [16,18,20]. These results confirmed the potential of using the CO_2 curing process for improving the mechanical properties of concrete products made with recycled aggregates.

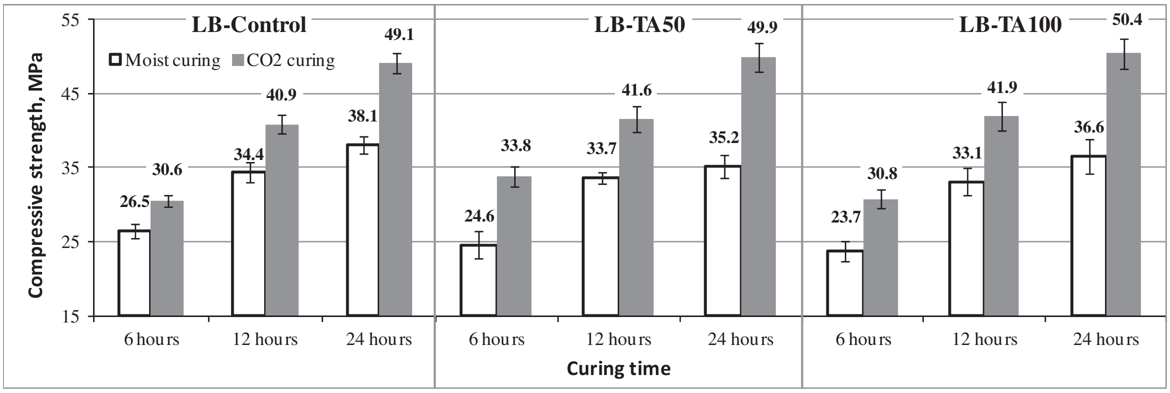


Fig. 8. Comparison of compressive strength between moist curing and CO_2 curing samples – LB Series.

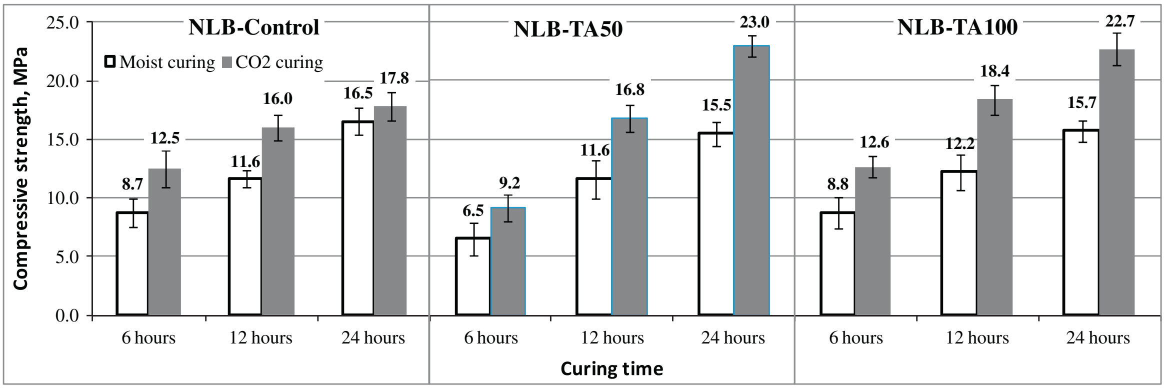


Fig. 9. Comparison of compressive strength between moist curing and CO_2 curing samples – NLB Series.

Table 3
Ratio of strength with curing time (compressive strength ratio of CO_2 cured sample to that of corresponding moist cured samples).

Samples	LB-control	LB-TA50	LB-TA100	NLB-control	NLB-TA50	NLB-TA100
6 h	1.15	1.37	1.30	1.43	1.41	1.44
12 h	1.19	1.23	1.27	1.38	1.45	1.51
24 h	1.29	1.42	1.38	1.08	1.49	1.45

3.4. Drying shrinkage

Table 4 shows the 14-day drying shrinkage value of the samples. Compared to the moist curing method, the CO_2 curing process reduced the shrinkage, and all the values were less than the stipulated limit (0.060%) of BS 6073 for concrete partition blocks [33]. This might be due to the carbonation of concrete products producing irreversible shrinkage rapidly [16]. Furthermore, the carbonation products, which had a higher molar volume than the original phases [14], could decrease the pore volume and permeability of the concrete products, thereby being able to decrease the reversible volume changes with subsequent variation of relative humidity [11,34]. However, it should be noted that the CO_2 curing time, from 6 to 24 h, had relatively insignificant effects on the 14-day drying shrinkage value of blocks prepared with or without TA. As shown typically in Fig. 10, there is no obvious pattern in the impact of CO_2 curing time on drying shrinkage value of LB-TA50 blocks from 1 day to 28 days. Further research on this matter is needed.

4. Implications

4.1. Enhancement effect

Although the reuse of RA can reduce the demand for limited natural recourses and thereby conserve natural raw materials, the negative effects of RA on concrete products should not be ignored. Due to the lower density and higher water absorption, the compressive strength of concrete blocks made with RA is normally lower than that of the corresponding reference concrete blocks. Table 5 shows the 28-day compressive strength loss of concrete blocks versus replacement ratio of RA [3,4,35]. The strength loss varied from the minimum of 5.2% to the maximum of 60.7%, with the replacement ratio of RA from 20% to 100%. But according to the results shown in Table 3, a 24 h CO_2 curing period would result in strength gains for 0%, 50% TA and 100% TA of 29%, 42%, 38% for the load-bearing blocks, and 8%, 49%, 45% for non load-bearing blocks respectively.

Table 4
Comparison of 14-day drying shrinkage value of CO_2 curing samples and moist curing samples.

Samples	CO_2 curing			28-day moist curing (%)
	6 h (%)	12 h (%)	24 h (%)	
LB-control	0.036	0.042	0.036	0.060
LB-TA50	0.054	0.052	0.058	0.072
LB-TA100	0.060	0.055	–	0.079
NLB-control	0.036	0.030	0.025	0.047
NLB-TA50	0.041	–	0.026	0.053
NLB-TA100	0.050	0.044	0.040	0.060

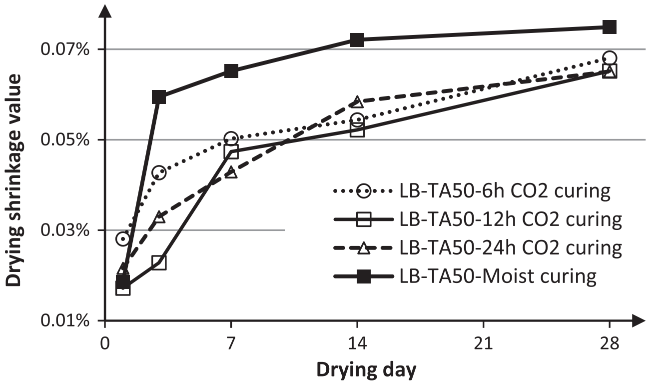


Fig. 10. Drying shrinkage value versus drying time for LB-TA50 blocks after moist and CO_2 curing.

Actually, in order to obtain comparable strength as that of the reference blocks, there are two common adopted methods: (1) addition of extra cement or pozzolanic materials and (2) use of steam or autoclave curing processes. Apparently, the former

Table 5
A list of 28-day compressive strength loss versus replacement ratio of RA in concrete blocks from previous work.

Previous work	Replacement ratio of RA (%)	28-day compressive strength loss (%)
Kaosol [35]	20	5.20
	50	10.20
	100	24.50
Poon et al. [4]	75	17.30
	100	30.70
Poon and Chan [3]	25	36.70
	50	48.90
	75	60.70

Table 6
CO_2 capture capacity of concrete blocks (m^3/m^3).

Samples	LB-control	LB-TA50	LB-TA100	NLB-control	NLB-TA50	NLB-TA100
6 h	28.02	28.34	30.08	24.00	22.19	27.00
12 h	30.11	33.88	36.07	35.03	30.82	30.35
24 h	36.03	43.96	40.88	33.74	35.76	34.52

Table 7
Profiles of annual CO_2 uptake by a medium-scale block manufacturing plant.

Block types	Size (mm)	Unit volume (m^3)	Annual production Units/ Volume (m^3)	CO_2 capture capacity	Annual uptake (Kg)
Load-bearing unit	200 × 100 × 50	1.0×10^{-3}	2×10^7/ 2.0×10^4	40	1.57×10^6
Non-load-bearing unit				35	1.38×10^6

method increases the material costs while the latter consumes massive amounts of energy to generate steam (1396 MJ/m^3 masonry [36]). With the surge in energy prices, both methods seem not very economical.

For comparison, the CO_2 curing process can enhance the strength of concrete blocks incorporating RA in a very short period ($\leqslant$24 h). It requires little energy input as the CO_2 gas can be recovered continuously from industrial CO_2 emission sources (e.g. power plants, cement plants and landfill gas treatment systems). If the CO_2 curing degree can be improved through optimizing the curing conditions, a more significant enhancement of strength can be achieved which would reduce the curing time required before the blocks are ready for use.

4.2. CO_2 capture capability

With the coming of the low carbon age, there are keen interests to explore high-efficiency and low-cost approaches for CO_2 capture and storage. Based on this initial investigation, an innovative CO_2 capture and storage method might have been found. As shown in Fig. 5, the curing degree of the blocks ranged from 13.41% (6 h CO_2 cured NBL-TA100 blocks) to 32.65% (24 h CO_2 cured NBL-TA50 blocks). In conjunction with the definition of CO_2 curing degree described in Section 2.4.2, the CO_2 capture capacities of each series of blocks were calculated and are shown in Table 6, where the values were determined as the volume of CO_2 (101.325 KPa, 293 K) captured by a unit volume of the blocks.

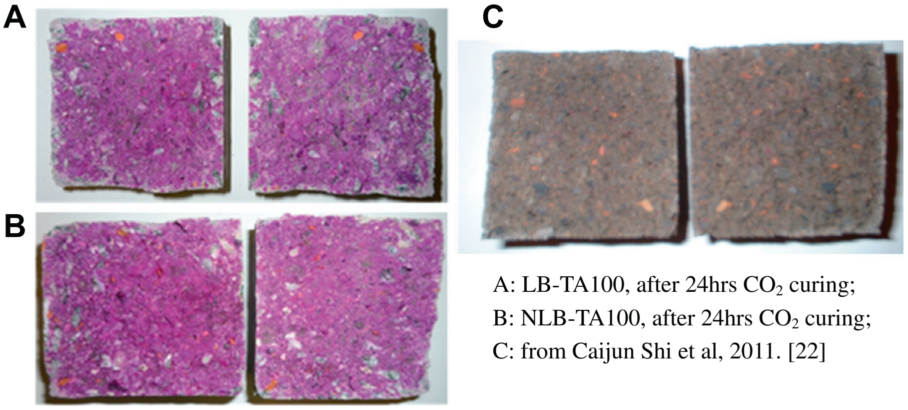
As an illustration of the potential application of the above CO_2 capturing process, it is assumed that the CO_2 curing process is adopted by a typical medium-scale concrete blocks manufacturing plant, with an annual output of about 2×10^7 (or $2 \times 10^4\ m^3$) pieces of blocks (nominal size of 200 mm × 100 mm × 50 mm). Considering that both non-load- (NLB) and load-bearing blocks (LB) are produced, the CO_2 capture capacities for NLB and LB blocks are assigned 35 and 40 separately, on the basis of the results in Table 6. Calculated from the conversion of volume and mass, the annual CO_2 uptake can reach 1.57×10^6 Kg (1570 t) and 1.38×10^6 Kg (1380 t) for LB and NLB blocks production, as shown in Table 7.

The above may be a conservative estimation as the CO_2 curing degree of the blocks has potential to be further improved, which can be demonstrated in Fig. 11. Apparently, the pH value inside the CO_2 cured lightweight concrete block samples [23], which was prepared with cement, sand and expanded shale lightweight aggregates, would be lower than that of LB-TA100 and NLB-TA100 blocks after 24 h CO_2 curing. The significant color variance from the phenolphthalein spraying test indicates that even with a CO_2 curing degree of 30%, the inner part of blocks after the CO_2 curing process used in this study was still not carbonated. If the CO_2 curing degree of the blocks can be further improved, the CO_2 uptake will increase consequently.

Furthermore, if the block manufacturing plant can be set up near the CO_2 emission source, such as cement or power plants, the flue gas can be transferred from the emission points to the curing facilities directly. This will save the cost of CO_2 capture from flue gas (28 €/t CO_2), and long-distance transport (1–6 €/t CO_2). It also reduces the cost of storage (1–8 €/t CO_2) and CO_2 leaking risk [37,38].

5. Conclusion

The results and discussion of this paper confirmed that the CO_2 curing process is an innovative method for producing concrete blocks incorporating recycled aggregate. In the course of 24 h CO_2 curing, the water loss and CO_2 curing degree of the blocks increased with curing time. However, the replacement ratio of recycled aggregate had inconspicuous influence on CO_2 curing degree, possibly resulting from the interference of the high water content of blocks with high percentage of recycled aggregate. Compared to conventional moist curing, CO_2 curing improved the compressive



A: LB-TA100, after 24hrs CO_2 curing;
B: NLB-TA100, after 24hrs CO_2 curing;
C: from Caijun Shi et al, 2011. [22]

Fig. 11. Comparison of results from phenolphthalein spraying on CO_2 cured blocks.

strength of both the non-load- and load-bearing blocks dramatically and rapidly with strength gains ranging from 108% to 151% within 24-h CO_2 curing time. Additionally, the drying shrinkage values of the blocks were significantly reduced by CO_2 curing.

The production of recycled aggregate concrete blocks with CO_2 curing shows great potential to capture CO_2. Additional work is required to optimize the curing conditions and conditions of the specimen to promote the CO_2 curing degree and CO_2 capture capacity.

Acknowledgement

The authors wish to thank the Hong Kong Polytechnic University and Sun Hung Kei Properties Ltd. for funding support.

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