Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Effect of CO_2-mixing dose and prolonged mixing time on fresh and hardened properties of cement pastes

Minlu WANG, Shuang LUO, Ba Tung PHAM, Tung-Chai LING

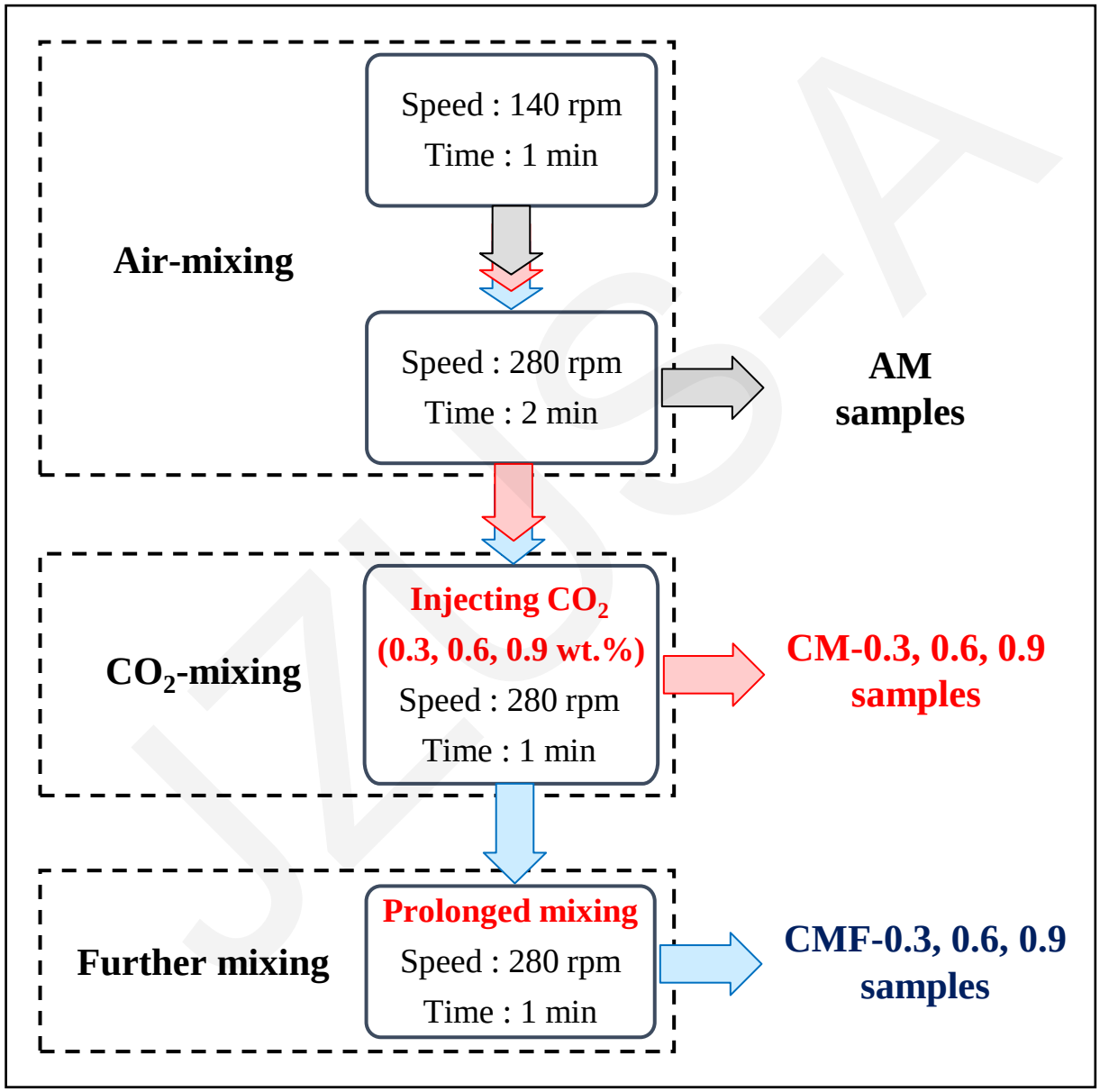
Key words:

CO_2-mixing; Calcium carbonate; Early cement hydration; Flowability; Microstructure

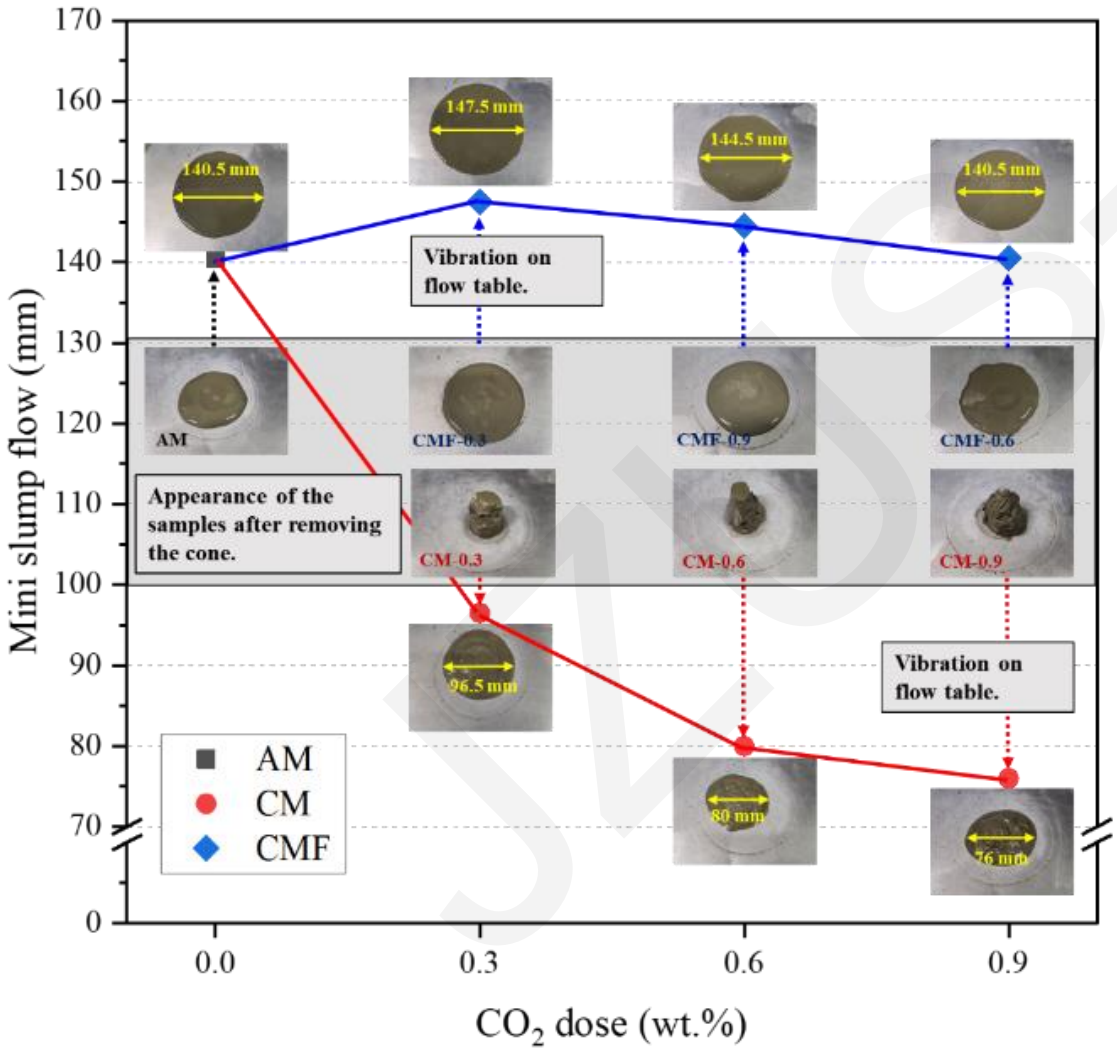
Cite this as: Minlu WANG, Shuang LUO, Ba Tung PHAM, Tung-Chai LING, 2023. Effect of CO_2-mixing dose and prolonged mixing time on fresh and hardened properties of cement pastes. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 24(10):886-897. https://doi.org/10.1631/jzus.A2200571

JZUSA

Methods

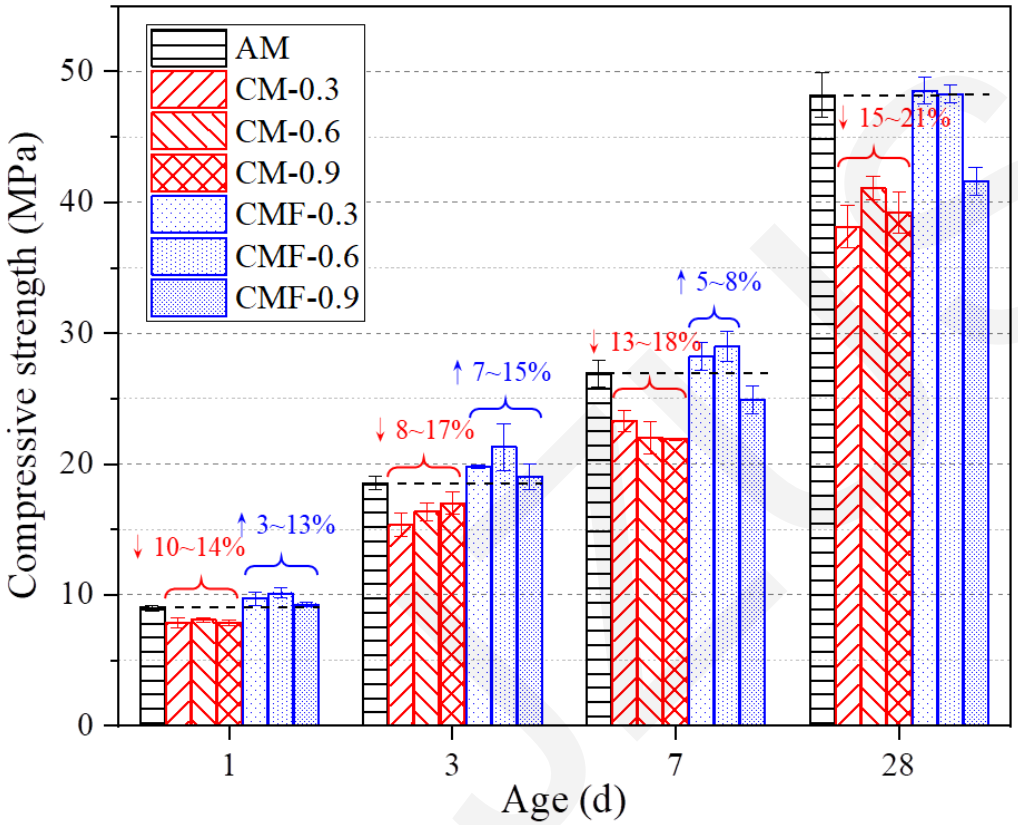

Air-mixing
Speed : 140 rpm
Time : 1 min
Speed : 280 rpm
Time : 2 min
AM samples
CO2-mixing
Injecting CO2
(0.3, 0.6, 0.9 wt.%)
Speed : 280 rpm
Time : 1 min
CM-0.3, 0.6, 0.9 samples
Further mixing
Prolonged mixing
Speed : 280 rpm
Time : 1 min
CMF-0.3, 0.6, 0.9 samples

Fresh Properties



- The flowability decreases dramatically with higher CO_2 doses, mainly associated with the flocculation network by the formation of hydrates and carbonates on the surface of the cement clinkers.
- With 1 min of further mixing, the workability of fresh cement pastes can be improved by ~53-85%.

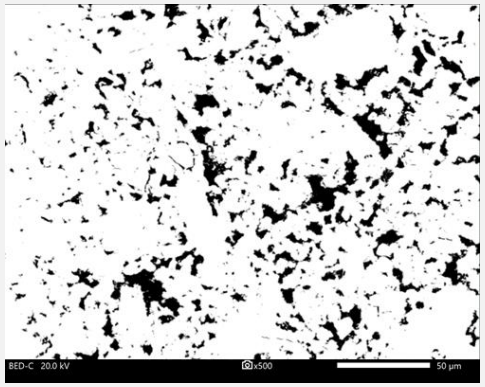
Hardened Properties



- The compressive strength of CM groups decreases by ~10-20% at all curing ages. This is because of the poor compaction of the fresh cement mixture, which induced more extensive pore structure.
- Upon 1 min of further mixing, the overall compressive strength is enhanced by ~18-32% (CMF groups); and demonstrated an early strength benefit of 3~15% compared to the control sample.

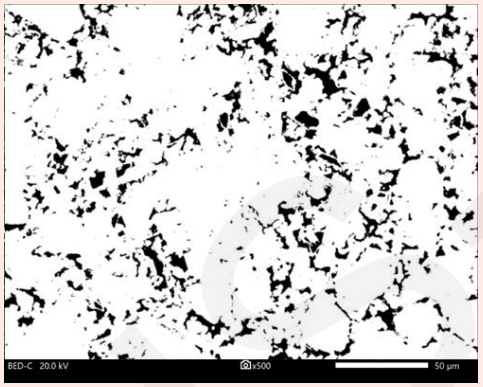
Porosity

AM-3d



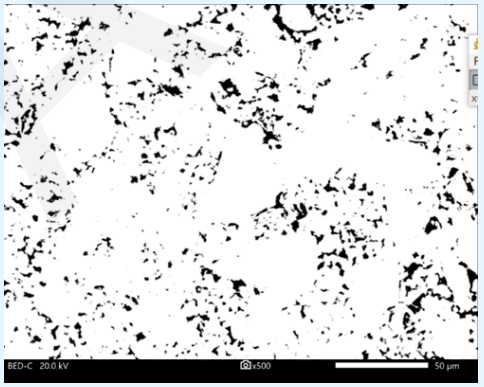
Porosity 12.15 %

CM-0.3-3d



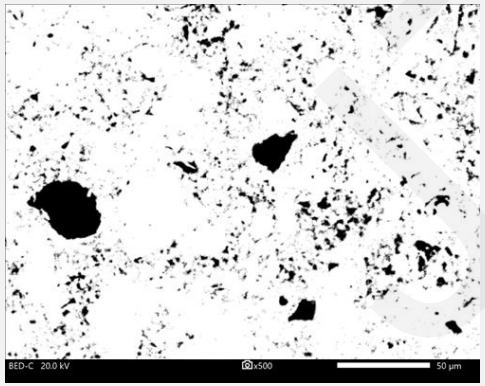
Porosity 11.63 %

CMF-0.3-3d



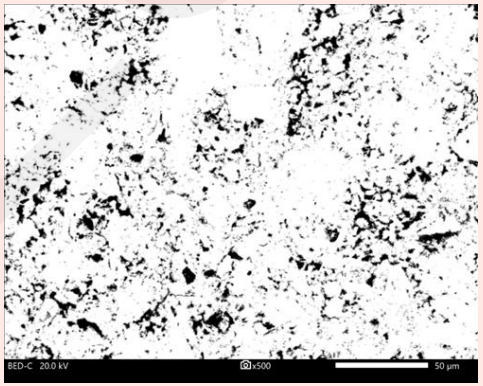
Porosity 10.55 %

AM-28d



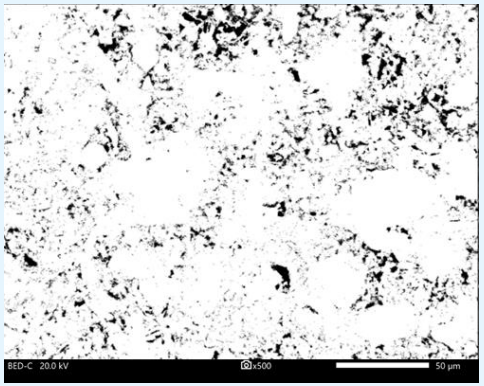
Porosity 7.79 %

CM-0.3-28d



Porosity 10.94 %

CMF-0.3-28d



Porosity 9.56 %

Conclusions

- The introduction of CO_2-mixing induces the formation of hydrates and carbonates on the surface of the cement clinkers, causing the flowability of the cement pastes decreases dramatically, and the compressive strength decreases by ~10-20% due to more extensive pore structure.
- With 1 min of further mixing, the flocculation network is broken up, thus the workability of fresh cement pastes can be improved by ~53-85%, and the compressive strength is enhanced by ~18-32%. This is due to the hydration-promoting effect of the deposited $CaCO_3$ and a more densified microstructure.