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

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**Key words:**

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

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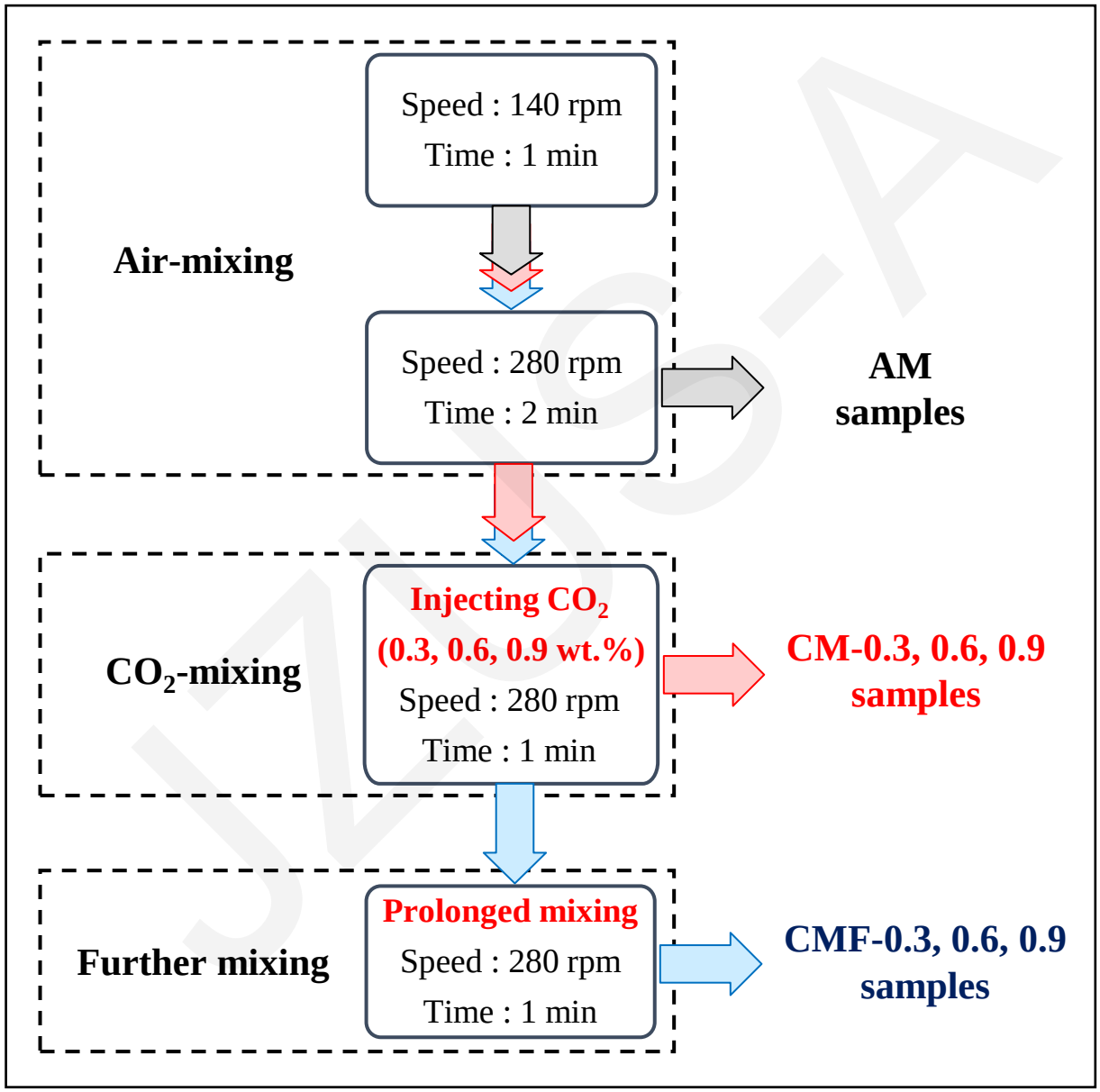
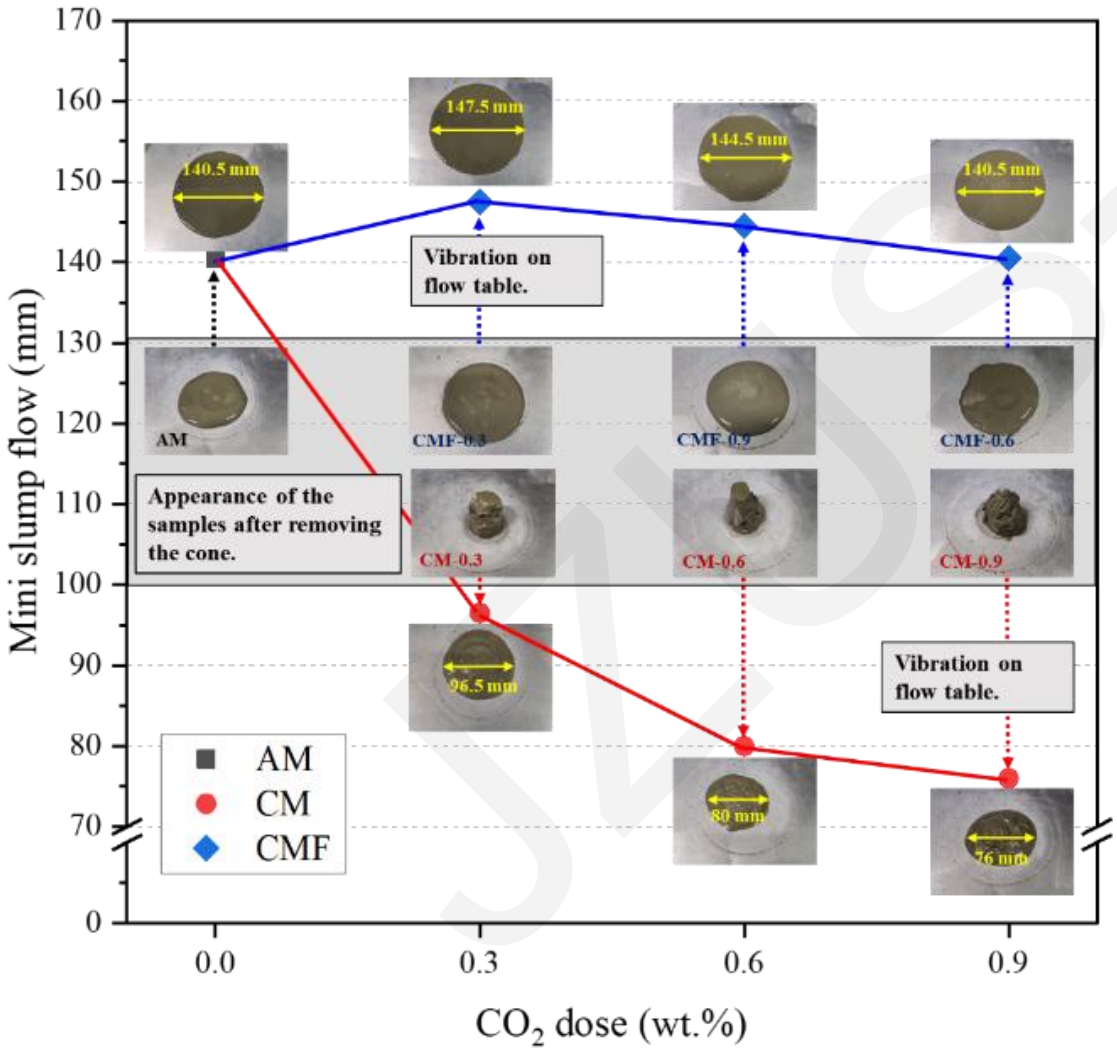
# Methods

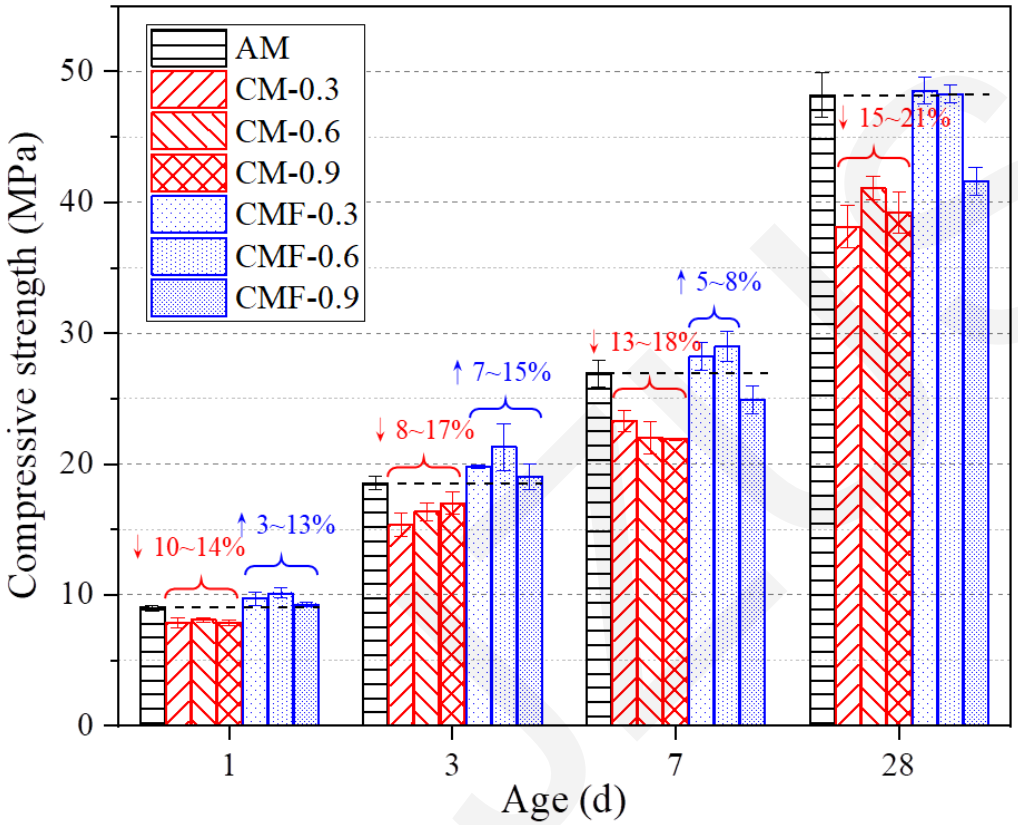

Air-mixing
Speed : 140 rpm
Time : 1 min
Speed : 280 rpm
Time : 2 min
AM samples
CO2-mixing
Injecting CO2
(0.3, 0.6, 0.9 wt.%)
Speed : 280 rpm
Time : 1 min
CM-0.3, 0.6, 0.9 samples
Further mixing
Prolonged mixing
Speed : 280 rpm
Time : 1 min
CMF-0.3, 0.6, 0.9 samples

# 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%.

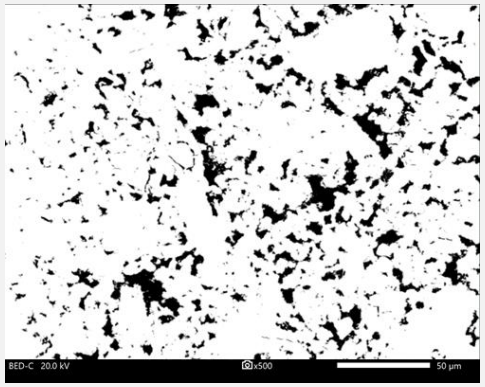
# Hardened Properties




- 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.

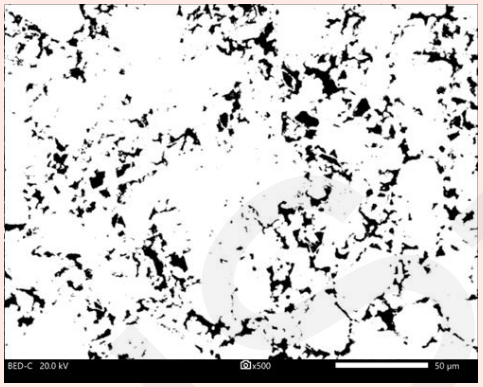
# Porosity

**AM-3d**



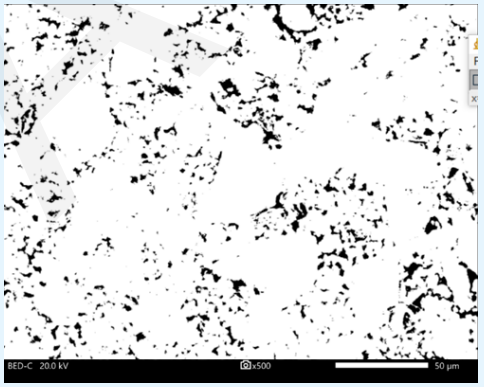
Porosity 12.15 %

**CM-0.3-3d**



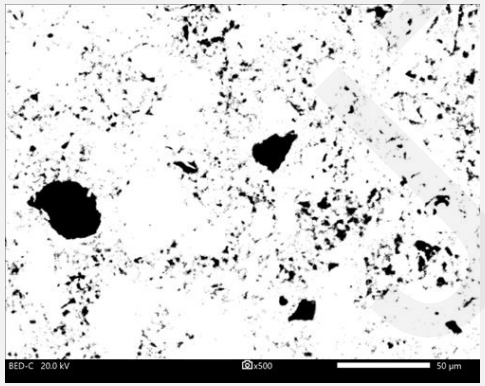
Porosity 11.63 %

**CMF-0.3-3d**



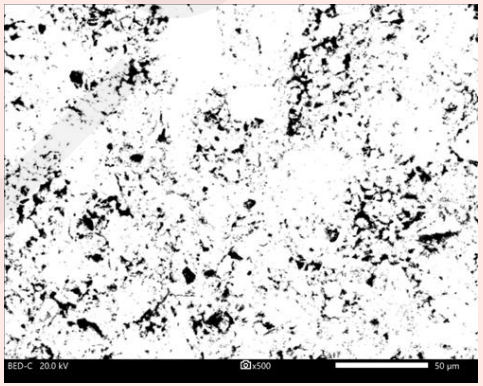
Porosity 10.55 %

**AM-28d**



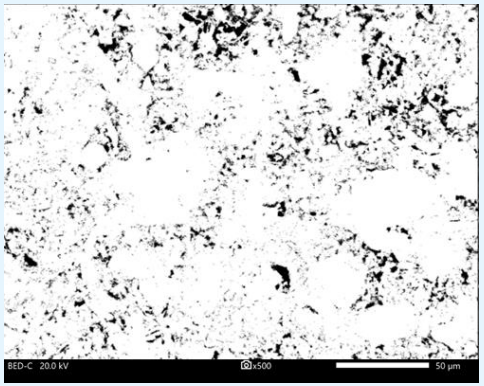
Porosity 7.79 %

**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.