SEM microstructural analysis of several concretes containing accelerator additives

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Background

The necessity of constructing new infrastructure and upgrading ageing infrastructure, coupled with global climate change (increase in precipitation), has prompted the demand for concrete with unique properties, such as early strength and early hardening.

Objective

- Obtaining three types of concrete with potential to exhibit early strength and/or early hardening properties through the incorporation of specific accelerators such as $Ca(NO_3)_2 \cdot 4H_2O$, $Na_2S_2O_3 \cdot 5H_2O$ and $Al_2(SO_4)_3 \cdot 18H_2O$
- Surface structural characterisation of obtained concretes using Scanning electron microscopy (SEM) with Energy dispersive X-ray spectrometry (EDS) technique at 28 days.

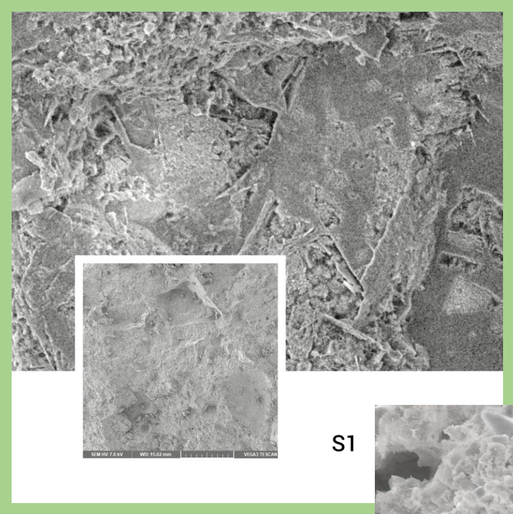
Experimental

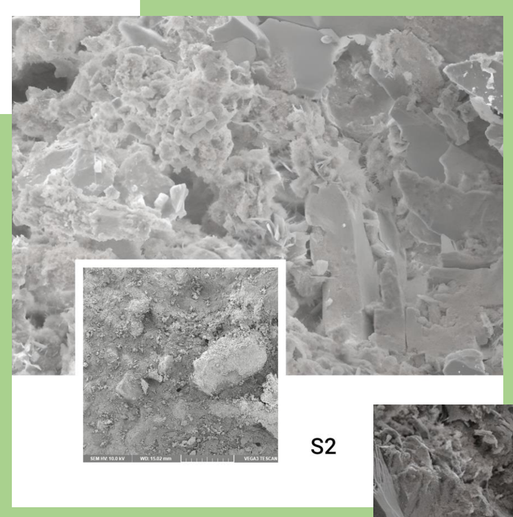
Concrete base composition: white cement CEM I - 52.5R, natural sand (0-0.4 mm) and coarse aggregate (8-16 mm)
Water/cement ratio: 0.4
Samples composition:

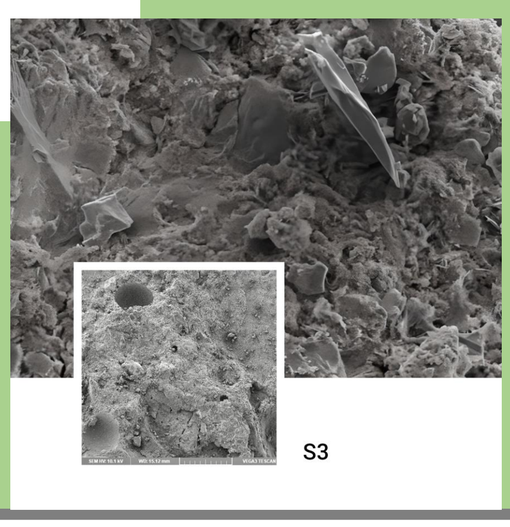
- Sample 1 (S1) – base composition
- Sample 2 (S2) – base composition + 1.5% $Ca(NO_3)_2 \cdot 4H_2O$ + 1.5% $Na_2S_2O_3 \cdot 5H_2O$
- Sample 3 (S3) – base composition + 1% $Ca(NO_3)_2 \cdot 4H_2O$ + 1% $Na_2S_2O_3 \cdot 5H_2O$ + 1% $Al_2(SO_4)_3 \cdot 18H_2O$

Equipment: Scanning electron microscopy (VEGA3 SBU, Tescan, Brno-Kohoutovice, Czech Republic) with energy dispersive X-ray spectroscopy (Quantax EDS, Bruker, Karlsruhe, Germany) SEM/EDX

RESULTS







Sample	Composition (%)					Ca/Si
	O	Ca	Si	Na	Al	
S1	59.32	20.78	16.16	1.90	1.84	1.28
S2	55.33	23.88	18.54	0.92	1.33	1.29
S3	57.41	26.98	10.31	2.85	2.45	2.61

Conclusions

1) At low magnification (~ 37x), all samples exhibit irregular surface characteristics
2) At high magnification (~ 1kx), all samples exhibit characteristics indicating the presence of ettringite and calcium hydroxide (CH)
3) The results of the elemental composition analysis indicated the presence of oxidized elements, calcium, silicon, sodium, and aluminum in all samples, in varying amounts
4) Ca/Si ratio is increasing with the addition of accelerators, indicating the decrease of calcium silicate hydrates and their replacement with other Ca-based phsaes.

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